The Builder.

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Over the Scottish Border.

WE have all heard stirring tales of Border warfare; Border minstrelsy has charmed our boyish ears; the veil of romance which Sir Walter Scott has cast over the scenes of pillage and rapine enacted for centuries in the Border counties has invested them with a fascination which has outlived many modern three volumes. To us, indeed, these tales may have seemed little more than visions, though suggested by real events perhaps; but the real events were too far away in the past to excite any desire of grasping their actual significance, and the whole series shone bright but ill-defined through the glowing atmosphere conjured up by the romancer. But a visit to the country where they occurred, an examination of the castles in which the actors lived, brings home to the imagination the reality of the deeds and the characteristics of the doers.

The castles, or Peel-towers, as they are called, of the Border, are distinct from anything south of that indefinite tract, unless it may be a Norman keep. Now a Norman keep is a thing of antiquarian interest, but the daily life that went on within its walls appeals to but few. The records are scanty, and known to hardly any besides Dr. Dryasdust, whose manner of imparting information is not popular. If we go to the Bayeux Tapestry the curious figures there delineated seem to have but little in common with us of the nineteenth century. But imagine a Norman keep built in the seventeenth century, after John Thorpe was dead, and inhabited by the contemporaries of Inigo Jones, and you find the task of peopling it with inmates a little less difficult. It is true that the simplest type of a Peel-tower was not very much in use in the seventeenth century, but in all essential features the convenience and accommodation that suited William the Conqueror's followers were sufficient for the borderers till after James I. came to the throne.

In case we should be too much inclined to hold the wild deeds related of this part of the world to be little besides the raw material of the novelist, let us hear what a grave writer had to say some four years after the crowns of England and Scotland were united under James I.

Camden, in his "Britannia" (1607), says of his design of dealing with Scotland:—"For this, I assure myself of pardon, both from the good nature of the people themselves, and in regard of the extraordinary happiness of our times, when, by Divine providence, *that* is fallen into our hands, which we durst hardly hope for, and which our ancestors so often and so earnestly wished to see, namely, that Britain, which for so many ages had been divided in itself, and been a kind of unsociable island, should (like one uniform city) be joined in one entire body, under one most august monarch, the founder of an everlasting peace. Who, being through the propitious goodness of Almighty God, appointed, and born, and preserved, for the common good of both nations, and a prince of singular wisdom, and fatherly affection to his subjects; doth so cut off all occasions of fear, hope, revenge, and complaint, that the fatal discord, which hath so long engaged these nations, otherwise invincible, in mutual wars, is now stifled, and suppressed for ever, and concord exceedingly rejoices, and even triumphs, because, as the poet sings:—

> Jam cuncti gens una sumus,
> Now all one nation, we're united fast.

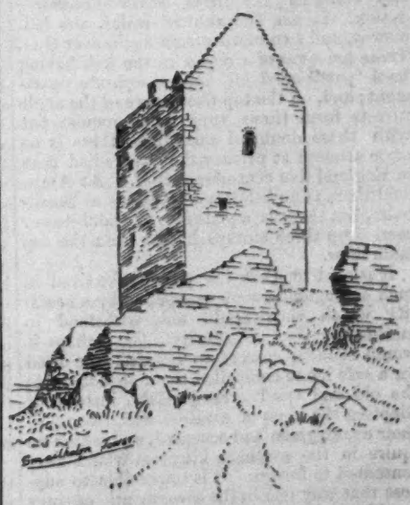
To which we answer by way of chorus.

> ——— Et simus in ævum.
> And may that union for ever last."

Further on, in enumerating the main divisions of the country, he divides them into Highlanders and Lowlanders, and adds, "out of this division I exclude the Borderers, because they, by the blessed and happy union, enjoying the sunshine of peace on every side, are to be look'd on as living in the very midst of the British Empire; and (being sufficiently tired with war) begin to grow acquainted with and to have an inclination to peace."

The worthy Camden, therefore, had a vivid sense of the feuds that abounded in the Border country; and in a casual manner he constantly recurs to this subject, his remarks being all the more striking because not intended to enforce this point. In dealing with "Teifidale," or Teviotdale, he says, "It is inhabited by a warlike people, who by reason of the frequent encounters between the Scots and English in former ages, are always very ready for service and sudden invasion." In Liddesdale, again, he says, "Hard by is Brakensey, [better known to modern ears as Branksome, the scene of the 'Lay of the Last Minstrel'] the seat of the warlike family of Buccleugh, sir-named Scot; with many little forts of military men, up and down the country."

It is these "little forts of military men" which we are now about to visit. And first let us go to Smailholm, lying midway between Kelso and Melrose. Here we have the wants of man supplied in about as bare a manner as is possible. The Tower stands on an abrupt mass of rock precipitous on all sides but one, where it is strengthened by a thick wall, through which the enclosure was



entered (see sketch). The enclosure was about as large as an ordinary stable-yard, and occupied most of the flat top of the rock, the remainder being taken up by the tower itself. That was the whole of the homestead,—the tower and the yard. If there were any outbuildings in the yard, they were insignificant, and only meant for cattle. The tower was the home of the chief, and when we consider that it was his home till comparatively modern times, an inspection of its bare interior will give a good idea of the difference that existed between the civilisation of Scotland and England at the time of the union of the Crowns.

The tower contains four apartments, one above another, about 25 ft. long by 17 ft. wide, access from one to the other being obtained by a circular stone staircase in one corner. The lowest room was a store-place, with a loft in the upper part, whither the servants probably climbed to seek such

repose as they might. This cellar was vaulted, with a plain barrel vault, forming the floor of the room over, which was the hall. Over this hall were two other floors of wood, the uppermost of which communicated with the battlements. Only the three upper rooms had fireplaces. The cellar had a narrow window, the other rooms had windows somewhat larger, but still small, and provided with stone seats on each side of the recess formed in the thick walls. The hall and the room over had each a latrine leading out of one corner, and formed in the thickness of the wall. A few recesses by way of cupboards—and that is the whole of the provision made for the comfort of the lord of Smailholm, his lady, and the household. Anything more bare could hardly be imagined, and, when we remember that such an eyrie was the Scotch representative of our Elizabethan manor-houses, we can easily appreciate the benefits that sprang from the union, and the cessation of hostilities which it ultimately brought about. Smailholm was the scene of Scott's ballad, "The Eve of St. John," but the "chamber to the east," the abode of the priest, is a poetic licence, and so, too, is the "chamber fair," where the lady slept, unless it were plentifully hung with arras to hide its present desolate appearance.

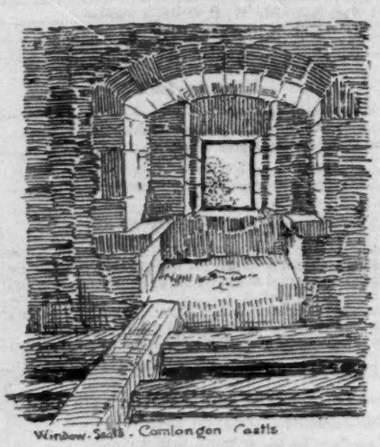
The exact date of Smailholm is difficult to determine, but Messrs. McGibbon and Ross class it among examples subsequent to 1542 in their excellent book on "The Castellated and Domestic Architecture of Scotland." At Amisfield, however, in Nithsdale, there is the date 1600, together with the arms of the owners and the initials of one of them. This, if not the actual date of the erection of the tower, shows at least that at that time it was the home of the family, and embellished as such.

This home of a Scotch laird in 1600, though more ornate than Smailholm, is no larger, and contains but little better accommodation. It has the vaulted cellar, the hall over it, and two more rooms again over that. There are signs of a recess in the hall having been partitioned off into a separate apartment; and, on the top floor, three of the angle turrets form three very small rooms; but with these doubtful exceptions there is no more attempt at privacy than there had been in England five centuries earlier. At Amisfield there is no battlement-walk as at Smailholm, but there is a picturesque watch-tower carried up three storeys higher than the top main floor.

It is evident that the people who lived in such strongholds were compelled by a necessity which they could not withstand to sacrifice comfort to security. Or perhaps it would be more correct to say that the need for a safe home compelled them to adhere to the old and tried arrangements, instead of adopting the ideas of comfort which some of their countrymen had accepted, and which no squire in the southern kingdom would have consented to forego. It is impossible to suppose that any one in the seventeenth century would have neglected the refinements of the age, had they been in a position to have availed themselves of them.

Smailholm and Amisfield are examples of the small and simple Peel; but there were others of the same general type, but with more conveniences introduced. Such are Comlongon in Dumfriesshire, and Elphinstone in Midlothian.

They are both considerably earlier than the other two, which shows that the latter were not built in so plain a manner for want of existing examples to follow. Comlongon has the usual number of floors: the vaulted cellar, with a loft in it; and the hall, and two rooms over it, all about 30 ft. by 20 ft. But here in the walls, which are from 10 ft. to 13 ft. in thickness, are contrived numerous little chambers, without any fireplaces it is true, but still separated from the main rooms. The latrines open from some of these instead of from the hall; there is a separate kitchen, though it is very small; and the battlements have covered guard-rooms, one of which has a fireplace. There is, throughout the place, a certain striving after ornament; the fireplace and almonry in the hall have an unusual amount of work lavished upon them, and many of the floor corbels are carved with coats-of-arms. In addition to the main staircase reaching from top to bottom, there is a second leading from the hall to the cellar. The windows and window-seats are somewhat larger (see sketch), and



altogether we have here quite a superior tenement. Not the least interesting feature is the dungeon. It is contrived in the thickness of the wall, and is some 18 ft. long by 6 ft. wide and 9 ft. high. The only access is through a manhole in the barrel vault; there is no window, and the only means of ventilation seems to have been an opening at one end, which found a devious way into the open air. The fate of any one consigned to this place was hardly to be envied.

Elphinstone Castle is even more elaborate. Each floor is about 30 ft. by 20 ft., surrounded by thick stone walls. Over the vaulted cellar and loft is the main hall, a high vaulted room, and over this is a floor divided into two in its length; while over this again was another floor, giving access to the battlements. The thick walls are riddled with little chambers, some leading direct from the main rooms, others contrived as mezzanines off the stairs. There are more stairs, too. Some, of small diameter, lead from floor to floor, and to the wall chambers already mentioned; while one, as much as 8 ft. in diameter, commences at the great hall, and leads direct to the battlements. By this means the men-at-arms were able to pass between their two places of chief resort without going near to any of the private apartments. Here, too, there is a separate kitchen, but there is no such dismal dungeon as at Comlongon, though, no doubt, one of the numerous wall-chambers would often serve the same purpose.

Distrust of both friend and foe governed the arrangements of these "little forts of military men." The contrivances against the foe are sufficiently obvious. The thick walls, the uninflammable vaulting, the small windows, the well-guarded external doors, some of which were on the second floor and reached only by ladders (in which case the doorway on the ground floor and the staircase to it would be blocked during an attack by anything that could be spared)—all these are patent enough. But against friends curious precautions were sometimes taken. Here at Elphinstone is a kind of spy-hole contrived through the flue of the great hall, to overlook that apartment and to communicate with a little chamber approached only by a private stair. In another castle an opening has been contrived leading from a recessed window, where the unsuspecting members of the household would retire for private conclave, to a chamber in the wall accessible only to the owner, and where, quite unsuspected, he could hear everything that was said.

These examples are only four out of many hundreds that abound in all parts of Scotland. With all the rudeness of manners which their arrangements imply, they were the homes of chieftains from whom some of the best of the Scotch families are descended, and, which is the most striking reflection, they were deliberately adopted as the only safe residences at a time when every English village had its new or modernised manor-house, in which all thoughts of defensive arrangements had been abandoned, and in which the increasing comfort of the times had multiplied apartments, had given them wide and handsome fireplaces, and, above all, had let in floods of daylight upon their carefully-designed and elaborately-wrought ornament.

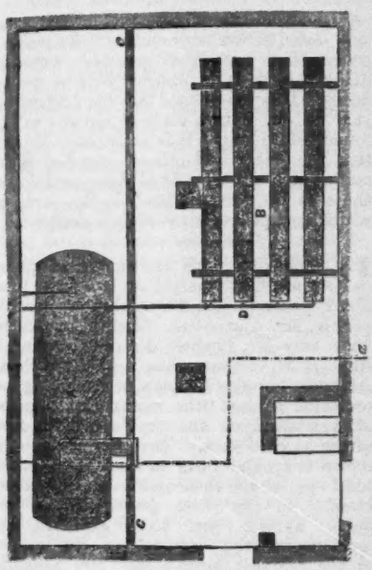
NOTES.

WE are glad to observe, in connexion with the munificent gift of a quarter of a million by Sir E. Guinness for the purpose of building dwellings for the poor in London and Dublin, that there appears to be a decisive intention to administer the fund on the only principle on which it is of any real use to administer such a gift, viz.: for the provision of buildings on an economic basis. The Peabody Fund, owing to the ignoring of this wholesome principle, has been, in our opinion, a conspicuous failure in regard to the real object originally professed. It has not provided houses suitable to the very poor, and it has not established any, as far as we have heard, on a really remunerative basis. At the same time, we cannot ignore the fact that the difficulties in the way of doing this are very great. We can only trust that the trustees of the new fund will not find them insuperable. A daily paper exhorts them to consider architectural beauty in the buildings erected. We quite sympathise with the spirit of the recommendation, but we fear that is almost out of the question. The problem is to produce a wholesome dwelling of sound construction, so cheaply as to let at the rents which the lowest class who pay any rent at all are now paying, and to yield a fair profit to the administration. This has never really been accomplished yet. A difficulty of another kind exists in the habits of the class themselves who are intended to be benefited. They must be kept under rules and regulations, or they will ruin the property: and such is the dislike of the lower classes to regulation, that many of them would prefer to live in a hovel as they please, to living in a clean house under supervision. "Go out into the highways and hedges and compel them to come in," will perhaps be the practical upshot of the scheme. They will be at least be nearer the kingdom of heaven in clean and decent houses than they can well be in dirty and unsanitary houses; and perhaps the next generation, at all events, may have learned the lesson which will have to be forced upon the poor of the present generation.

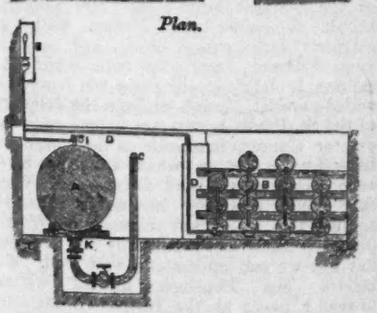
A LARGE party of engineers and architects met at the South Kensington Museum on Monday afternoon, to inspect Mr. Vinning's high-pressure fire-hydrant system which is installed there, and to which we have before referred. This is a system, applicable to any large building in which the extent and importance of the "fire-risk" justify the necessary expenditure,* for keeping always ready at a moment's notice the power of throwing a jet of water the whole height of the building, by air-pressure derived from storage of compressed air. On the accompanying plan and section, B represent fourteen wrought-iron cylinders each 14 ft. long and 12 in. diameter, connected by tubing so as to be practically one vessel, and filled with air at a pressure of 350 lb. to the square inch. From the bottom tier of cylinders a pipe (D) is carried upwards to a pressure-lever and

* In regard to cost, Mr. Vinning writes:—"The cost of an installation identically the same as that at South Kensington Museum would be from, say, 450*l.* to 550*l.*, according to structural conditions. This would be often modified and considerably reduced—(1) where buildings were of much less elevation; (2) where the apparatus can be put on the roof."

pressure-gauge board fixed against the wall in the roadway above. Here the pressure is retained by a check-valve within the valve box, above which a pressure-gauge shows the maintenance of the pressure at the required 350 lbs. From this the pipe is continued to a regulating and reducing valve, and from thence is carried downward to the top of the water-tank, at its junction to which is fitted a weighted safety-valve and a small float-ball valve (I), which permits the air to pass upwards through it when the tank is being filled with water, but closes by floatation when full. At the base of the water-tank, a similar float-ball valve (K) falls when all the water is discharged, and prevents the compressed air from entering the fire mains. On the pressure lever being pulled downwards, the valve is opened and the compressed air passes through the regulating and reducing valve, and downwards on to the surface of the water, which is then—on the opening of any of the fire-cocks all over the building—delivered from the high pressure



Plan.



Section.

tank (A) at 100 lbs. pressure. The result of this is that the Museum has, at instant command, at its highest point—an elevation of 110 ft. from the ground level—about 120 ft. head or 51 lbs. pressure instead of the present head of 20 ft. or 8 lbs. pressure, and this entirely free from the risk of any temporary failure of the external public supply. The air-cylinders are charged to the necessary pressure of 350 lbs. to the square inch, by means of a number of steel bottles or tubes, of portable shape and weight, containing compressed air at a pressure of from 1,500 to 2,000 lbs. These bottles are delivered by the patentee, and removed after charging the cylinders—a work of a few minutes. This is a very convenient method of charging the air-cylinders, where it is not found convenient to provide an air-pump and the necessary power for driving it; which would usually be a one to three horse-power engine, or its equivalent in manual, water, or other power. The tank contains sufficient water to supply a hose with a ¾ nozzle for about twenty minutes, doing the work of a fire engine until the engines can be got to the spot, and affording the means of contending instantly with the first outbreak of a fire, without having to trust to the necessarily varying and often quite inadequate head of pressure in the company's water-mains. The exhibition of the action of the hose under the air pressure was perfectly satisfactory, and showed that here was a power placed in the hands of the custodian of the building equivalent to a powerful fire engine on the spot and always in gear. We expressed some doubt on a former occasion as to whether the stored compressed-air power could be trusted for an indefinite period; but with care in the manufacture of the containers it seems quite possible to secure practical freedom from leakage, and the pressure-gauge, at all events, shows at any time if the pressure is declining. It would be of course advisable to test the working once in six months or so, to see that all is right; but there is nothing about the apparatus that is at all liable to get out of order.

THE scheme for a ship-canal between the Forth and the Clyde has during the past two months continued to be somewhat diligently canvassed on a local footing, with Edinburgh as the headquarters of the movement, but the progress looked for, and some time ago prospectively announced as within view, has not been realised. No application will be made during next session of Parliament. Glasgow, upon whose advancement the cutting of such a canal would exert an influence of the greatest importance, has been, or seemed to be, singularly apathetic during the discussion of the question; but there may be cause for this, so far as the Town Council and the Clyde Trust are concerned. If the canal were cut at the narrowest crossing, about fifteen miles of the already canalised Clyde would be used by the through navigation, and sailing powers to that end taken in the Act of Parliament. A full rate of tonnage dues charged for this accommodation might be, and very likely would be, fatal to the financial success of the new enterprise, and an agreement on liberal terms previously concluded with the Clyde Conservators is therefore a necessity. In a matter calculated to confer benefit on them from almost every conceivable quarter, the latter might well be not only generous, but eager; but perhaps they calculate that by affecting indifference now they may drive the harder a bargain when the time for bargaining arrives. Probably to hold this tendency in check the promoters have meanwhile been talking of the old suggestion of a roundabout route *vid* Loch Lomond,—of more than double the length, and involving a deepening of the Forth at one point, and passing it by syphon under the canal at another; also dealing with the River Endrick in a similar way, and tunnelling mast-high for some miles under two lofty ridges of hills, but making no use of the deepened Clyde, and keeping Glasgow at a distance. It is not likely that Glasgow will be seriously frightened at this; but it may bring about what is desirable, if the canal, on a reasonable route and scale, is ever to be made, and that is the assumption by the western city of the leading place in the movement, and the abandonment of its present position of mere watcher.

A LETTER has just been addressed to the Railway Companies' Association by the Board of Trade, pointing out the desirability of giving earlier notice of intended alterations in the passenger train service. This action may perhaps be looked upon as a sequel to the chorus of complaints which recently appeared in the *Times* on this subject, led by the Bishop of Wakefield. It is probable that the remonstrance from the Board of Trade will have far more weight than the newspaper appeals, and that some improvement may at last be looked for. Time-table alterations involve far more work than the uninitiated would imagine, but this is not a sufficient excuse for the delay in announcing them which has given rise to this remonstrance. The Department unearthed a letter dated April, 1878, in which it was promised that "the several companies will endeavour to publish any alterations they may make in their train arrangements at each station one week before the expiration of each month, and also advertise them as early as possible." This (as most persons who travel frequently will know to their cost) has, apparently, been found impracticable hitherto. It is often impossible to know of train alterations until after they are an accomplished fact, and very seldom, indeed, "one week before." The Board of Trade only ask the companies to give the desired publicity to these changes "a reasonable time before they come into force." The least the latter can do is to carry out the arrangement of 1878, and we hope we may soon find "Bradshaw" on the bookstalls several days before the first of the month.

WE hear that the Caledonian Railway propose to apply for power to construct an underground railway from the station at Lothian-road, Edinburgh, through the centre of the city. The proposed new railway would leave the present terminus on the north side of the station at a level of 12 ft. below the existing platform. Crossing Lothian-road, it would run under Princes-street near to the Gardens, with a station at the east end of the street, proceeding under Waterloo-place, Regent-road, and Royal-terrace to Greenside, from whence it would run in the open to the foot of Leith-walk. At this point the line would fork, one branch running to the new docks at Leith, and the other to the existing Caledonian railway near Granton-road, thus completing the circle. The scheme involves the erection of a new station at Lothian-road, that at present in use being a temporary wooden structure in a dilapidated condition.

THE Military Exhibition in Edinburgh has given rise to a desire for the formation of a National Armoury for Scotland. It is thought that the newly-restored Parliament House in the Castle would form a suitable habitation for the collection. Besides the arms in the Exhibition at the Scottish National Gallery, there are said to be specimens of good armour scattered throughout Scotland which the owners might be induced to add to a national collection, and the armoury at the Tower, which is overcrowded, could easily spare others which are stored there.

IN our article on "Concrete Floors" (October 26), referring to the correspondence on the subject set on foot by Mr. F. Caws, we referred to a concrete floor given by Mr. Caws as the largest he had yet attempted to construct, being 30 ft. by 19 by 7 in. thick, but which was then still in process of construction. We referred to it as having a dangerously small factor of safety. Mr. Caws now sends us further particulars as to this floor, of which the centres have been struck after having stood for three months. The size of the slab of which the centres have just been struck is, it appears, 26½ ft. by 19½ ft., but by the process of corbelling round the edges (*i.e.*, casting the concrete round the edge in a corbel section), the bearing of the thin portion of the slab is practically reduced to 25 ft. by 18 ft. The admixture was one of best old cement to four of hard broken brick aggregate. The centering was 2½ in. planking supported in a perfectly firm manner on joists and posts. Over the centering a film of plaster was spread, so as to make a fair surface for finishing the ceiling. Over the plaster a grout of pure cement was spread as a guarantee against air holes appearing in the finished ceiling surface. Upon the wet grout the concrete was cast about 5½ in. thick, with the aggregate broken not larger than a hen's egg. Finally, the finishing layer, 1½ in thick, was laid, formed of cement with very fine broken brick or granite chips. "Immediately after the removal of the centering," Mr. Caws writes, "we fitted a rod vertically tight between ceiling and floor. The rod is 14 ft.

long, and a lateral deflection of 2 in. would show vertical deflection of $\frac{1}{12}$ in. in the centre of the slab. The rod has deflected barely $\frac{3}{4}$ in. laterally, so that the centre of the slab has deflected vertically about the thickness of a well-worn sixpence. On the top of this slab there is a ½-brick partition wall, built about 12 ft. high, with no support except that of the slab. There are also the props of the centering supporting the slab of the next floor above." The 4½ brick wall and the scaffold posts do not however represent quite what may be called loading a floor. It would be more satisfactory to have details of a test load with figures given, and the effect on the floor noted.

DR. PAGE'S report to the Local Government Board * (September 30) on an epidemic of enteric fever in the Northern Division of the Houghton-le-Spring Rural Sanitary District, is very instructive in regard to the unsuspected methods in which water-supply may be polluted, and the patient thoroughness of investigation often required to arrived at the *fons et origo mali*. Examination of the district convinced the reporter that defective drainage was not the cause of the disease; one or two other possible causes (milk-supply, for instance) were dismissed, and water-supply seemed to be the only possible cause left to speculate upon; but there was nothing in the obvious circumstances of the water-supply to account for this. The following sentences extracted from the report give the points of the story:—

"The Herrington supply is pumped from a well or 'staple' sunk to a depth of 330 ft. into sandstone strata of the coal measures, into a service-reservoir holding 30,000 gallons, from which it is distributed by gravitation. This well, which was sunk some fifteen years ago for the special purpose of the water-supply of this district, is above the level of the colliery workings, and has no communication with them. For the first 72 ft. it passes through clay with sand partings or seams; for the next 15 ft. through limestone marl; and for the remaining distance through beds of sandstone and shale. The sides of the well are lined with bricks set in mortar, and up to the period of my inquiry were believed to be impervious, the water being described as entering the well at the bottom. . . . From the distribution of the fever over the whole line of the particular water-service, including, as now shown, its highest as well as its lowest points, it became evident that contamination of this service near its source would alone explain the circumstances of the outbreak. Although the early occurrence of cases in New Pit-row, as well as in Railway-terrace, was inconsistent with the view that pollution of the water had taken place in its passage through the service-pipes and thus brought about a general specific contamination of the supply, I thought it desirable to examine the relations of the main and the sewer where these were contiguous by the side of the railway. This was accordingly done, and both were thoroughly exposed in their entire length. As a result the sewer was found to be leaking at several points, but the water-main was quite intact, the joints of the latter, although carefully cleansed all round and tested for some time under full pressure, showing not the slightest sign of wetness . . . . Examination of the immediate surroundings of the reservoir and the well was next made."

This portion of the inquiry, given in considerable detail, afforded no satisfactory explanation. At last a careful examination of the sides of the well was made, and a "feeder" was discovered to enter it about 45 ft. below the ground, issuing from the brickwork at the rate of twenty-two gallons a minute. This water, taken direct from the fissure as it issued, gave a different analysis from that of the well-water rising from below, and showed "highly objectionable features." Eventually the origin of contamination was found in the premises of a farmhouse three-quarters of a mile off:—

"The farmhouse and buildings are upon the magnesian limestone, the beds of which dip towards the north. Owing to subsidences caused by the colliery workings below, fissures extending to the surface exist in this locality. The drainage of the farm-buildings, of a cottage, and of the farmhouse itself (in which latter there is a water-closet) are conveyed to a tank. The over-flow from this tank escapes and disappears down an adjoining fissure in the ground. To determine whether a connexion existed between this fissure (three-quarters of a mile from the well) at Herrington Hill farm and the water-bearing strata supplying the staple,' I suggested that common salt should be, dissolved and thrown down the fissure. Instructions were given to this effect, and two tons of salt were accordingly thrown down on May 11. At this date the discovery of the 'feeder' in the 'staple' had not been made, and testing of the water as pumped from the well did not give any conclusive indication of increase of chlorides. On the discovery of the 'feeder' a week later a clue to the excess of chlorides shown by it (as compared with the body of water in the well) was apparently furnished, and, as will presently appear, the source of the chlorides was in the end conclusively demonstrated. From May 24 a series of daily testings of the relative amounts of chlorine in the water of the reservoir and of the 'feeder' were made. The chlorine in the water of the reservoir varied from 2·3 to 2·8 grains per gallon, that in the 'feeder' from 4 to 6 grains per gallon. On May 29, with a view to placing beyond doubt whether the increase of chlorine thus shown was due to the salt thrown down the crevice at Herrington Hill, five tons of salt were washed down the crevice with a hose-pipe running for twelve hours, during which time it was estimated that some 100 tons of water was discharged. On the following day the chlorine present in the water of the 'feeder' rose to 15 grains per gallon. The testing was continued for a few days longer, and on June 5 the chlorine reached the maximum amount of 24 grains per gallon. During the next few days it fell again to the former amount. The connexion between the two localities, the farm-tank and the 'staple,' was thus conclusively established, and the source of excremental contamination of the water-supply demonstrated."

* Eyre & Spottiswoode, London; A. & C. Black, Edinburgh; Hodges, Figgis, & Co., Dublin.

IN a "Note" last week we adverted to Sir Sydney Waterlow's munificent gift of his Highgate estate (Fairseat) to the London County Council. At their meeting on Tuesday, 12th inst., Lord Rosebery intimated that this property comprises a traditionary home of Nell Gwynne, which will, perhaps, be now demolished. This we take to be the house—once tenanted by Lord Westbury—and known as Lauderdale House, which in 1872 Sir Sydney conveyed to St. Bartholomew's for the purposes of a convalescent home. It is said to have been built, *circa* 1660, for the Royalist, John Maitland, second Earl and first Duke of Lauderdale, who died in 1682. Here, as the story goes, the king conferred the earldom of Burford upon the infant Charles, the elder of his bastard sons by Nell Gwynne. That son's descendant, William, ninth Duke of St. Alban's, married the widow of Thomas Coutts, the banker, of Holly Lodge, hard by. The duchess, Harriet Mellon, continued to occupy the Holly Lodge, well known to our generation as the residence of the banker's granddaughter and heiress the Baroness Burdett-Coutts. In a cottage which formerly adjoined the grounds of Lauderdale House, and standing over against Cromwell House, lived Andrew Marvell. His home here and its garden are described in the late S. C. Hall's "Pilgrimages to English Shrines." Close to these is the retreat of the Passionist Fathers of St. Joseph, built after the designs of Mr. F. W. Tasker, architect, and dedicated by Cardinal Manning in 1876. The new buildings for the retreat have just been completed. It was originally established here, in 1858, by the late Honourable and Reverend George Spencer, where had hitherto been a once favourite hostelry, the old "Black Dog." The old Cromwell House, distinguished by its fine staircase, was restored after a fire that broke out therein about twenty-five years since. It is believed to have been erected by the Protector for his son-in-law, General Ireton; and had latterly served as a convalescent home in connexion with the Children's Hospital, Great Ormond-street. Cromwell-avenue has been built over site of the house and grounds. It is rumoured that the Small-pox Hospital, next to St. Joseph's, is about to be converted into barracks in connexion with a new scheme for the defence of London.

IN last week's number of *Engineering* is published a small illustration of the design which has been made by a certain Mr. Judson for an iron tower for the United States, to be 630 ft. higher than the Eiffel Tower. The design, even on the small-scale drawing given, serves at all events to show that, objectionable as the Eiffel Tower is, it is quite possible to produce something far more ugly as well as higher. This outbreak of tower projects was to be expected after the fuss made about the Eiffel Tower; and America is just the quarter of the world where it will be thought a kind of national duty to produce a tower that will outtop the French one. It is to be hoped England will be wiser.

WE observe from a paragraph in the *Liverpool Courier* that Mr. Dunscombe, the City Engineer of Liverpool, has declined to enter into a second competition for the post of Engineer to the London County Council. Mr. Dunscombe was one of those whose name we should have expected to see among the selected six of the previous competition; and we can quite understand his declining, under the circumstances, to take a second chance of such selection.

ALL who are interested in our great architectural monuments will have been concerned to learn that so noble a church as Selby Abbey is in danger from structural decay. It is to be hoped that the funds necessary to put it in a state of security will be found before long. It is satisfactory to learn that the Vicar and others interested in the matter have no thought of doing anything in the way of "restoration" in the sense in which that phrase is too often understood.

IN connexion with the subject of Selby Abbey, first brought up by a letter from Mr. Poynter in the *Times*, that irrepressible person Mr. Cavendish Bentinck writes to know why Mr. Poynter denounced "vandalism" at St. Albans when neither the Royal Academy nor the Institute of Architects had protested against "the most conspicuous act of vandalism of the day," viz.: the altar screen at St. Paul's. That the placing of a screen in apsidal form in front of the structural apse of the cathedral is an architectural blunder of the first magnitude we are quite agreed, and have expressed our opinion on the subject, at all events, in the plainest terms: but Mr. Bentinck should remember that Messrs. Bodley & Garner's architectural design and detail is very different from that with which St. Albans is defaced; the cases can hardly be called parallel, though perhaps the designers of the St. Paul's screen are in one sense the greater sinners, inasmuch as they ought to have known better, which could not have been expected of Lord Grimthorpe. Why the Royal Academy has never protested against this ill-devised intrusion on Wren's plan we know not; but why the Institute has not we can understand very well. We believe Mr. Bentinck himself wished to read a paper at the Institute denouncing the St. Paul's screen and its authors. Now inasmuch as the architects who designed the screen are not members of the Institute, to have admitted an amateur to make a formal attack upon them under the wing of the Institute would have been in the very worst taste, and would probably have given rise to serious misconception.

The New Government Buildings at Christiania.—Twenty-seven designs were sent in for the new Government buildings at Christiania, and the awarding committee has, by six to four votes, decided upon giving the first prize to Herr S. Letnow, architect, of Christiania. Four other prizes have also been awarded. However, the committee considers that none of the designs are acceptable for execution in their present form.

The Norwegian Wooden Villa Industry—In consequence of the attractive show of the exporters of wooden villas at the Paris Exhibition, numerous orders for similar structures have been received from southern Europe, in addition to which all these exhibits have been sold.

SOME SOURCES OF EXPRESSION IN ARCHITECTURE.*

"Had you been, in fine, anything else in the world but architectural designers, you might have been of some use and good to people."—"Two Paths," p. 149.

This is a fortunate time for the arts in Britain,—if for each art to be put upon its defence, and to be expected to carry its own warranty of worth, if for each artist to be compelled to strive for the honour and welfare of his own special line of work, be fortunate. But, fortunate or not, these conditions attend the pursuit of art nowadays, and mark the temper of scrutiny which sprang into existence with the overthrow of tradition in the early part of this century. Before this event art was of tranquil mood and peaceful growth, and, since Mother Eve span her pretty primeval fancies, or Tubal Cain tinkered brass at his tent-door, had run on in much the same grooves, with a grand human indifference to the canons of taste pigeon-holed by our modern art grammarians.

There was no scrutiny before this breach with tradition, for there were no critics; there was no anxiety, no annual fingering of the nation's art-pulse, for there was no malady to combat, only, shall we say, a little languor had seized the aged Titan as he rested in Sleepy Hollow where he came to his untimely end. But with the close of the great chapter of traditional art everything changed,—the age of peace was gone, and an age of revolution was inaugurated whose effects are upon us to this day. Hence our shiftiness, hence the much-ado and vague unrest of ardent minds that are for ever analysing the inner springs of art-life, looking into first principles, putting venerable things to the test that have passed unquestioned for thousands of years. Hence this art-parliament, where each of us in his turn is trotted out to prove his credentials as an artist, and to give an account of the hope that is in him, to his comrades and the critics with a fairly-informed but somewhat unreflective public looking on.

This much by way of preface to explain how it is that in this year of grace and of architectural achievement one should be here to defend the true dignity of architecture, and to claim the rank that both of courtesy and of right she has always held in the hierarchy of the arts. It is one of the ironies of art-history that this rank should be denied to the one art that has the longest and the grandest record, and that an architect should have to assert the claims of his art places him in an awkward position; for it means either that architecture is not what architects claim it to be, or that its rank as an art is misjudged and undervalued, or that, owing to the poorer quality of modern work, it has sunk so low in public esteem that people all round may run-amuck at it; and, as at Liverpool last year, the sister Arts will not so much as stoop to do her reverence.

Now, it is not my wish to make out architecture to be other or more than it is. Art is not a game of brag, and God knows we have good reason to be humble! I claim simply that architecture is an imaginative art, with noble ways of utterance, and a power of appeal as independent of the sister Arts as are painting, poetry, music, or sculpture. In illustrating this proposition, it concerns me not to defend the work of to-day as though proof of its unworthiness would dispose of my claims for architecture in the general. Not so. Yet, even if it were allowed that our work has not the solid merits of the old, surely something of the blame of this must be set down to the miserable utilitarian spirit of the age which clips our wings when we would soar, and something more to the overcrowding of the profession. Our having to supply work conformable to the imaginative standard of the British Philistine scarcely conduces, perhaps, to the heightening of the quality of architecture generally; and as to the second plea, you will not deny that while the number of practitioners has vastly increased, the ratio of genius remains a fixed quantity. While the world lasts,—let you and I congratulate ourselves upon it,—mediocrity is bound to prevail. High heaven is jealous of genius, and keeps it phenomenal when it does appear. Artists are still as rare as white crows.

Grant, then, that

"We are scarce our father's shadow cast at noon,"

and the fact remains that while the character and fashion of it may vary to any extent, not so the art. True, its structural types and instruments of expression have changed beyond telling: this only shows that the art of architecture is a liberal language that takes many strange accents to its bosom, and permits variety of local idiom or quality of speech without producing confusion of tongues. Thus, each city of Italy has its own school of device, its own fashion in building materials,—brick or stone, marble or terra-cotta; yet who shall say that the diverse fragmentary schools of design hindered the expression of the national mind or rendered that expression one whit less felicitous? And so, to spread the area of example indefinitely, I say, the diverse national schools of design all over the world, severally and collectively, only represent the many moods of a many-sided art.

But here you may interpose, "We quite agree with you as to the singular magic of old buildings,—that is not the question; there have been exquisite moments in art, and we hope that they'll recur again. Are you right, however, in ascribing the high imaginative qualities of these old structures to architecture pure and simple? This you must know is not the verdict of writers and talkers about art, of critics, sculptors, and painters, who say with one consent that architecture has no sources of expression independent of sculpture. Sculpture, they say, is the Alpha and Omega of architecture, the only high poetic quality in architectural design."

Such I know are the unpleasant things they say to vex us, and if we cannot agree with them 'tis because we know our business, and know that we know it. To argue, as these good people do, that a building is nothing until completed with sculptural embellishment is a strange inversion of the common-sense of the matter, for to a homely architect it is like arguing that a leg of mutton is not a leg of mutton without its trimmings: or, to use a more polite simile, it is like saying that lovely woman is not complete without her jewellery.

It was Mr. Ruskin who first set the fashion of detraction, and first launched this theory, since when it has become a perennial platitude that never stales. In his "Two Paths" he is good enough to allow that architects may possess that poor sort of invention which produces pretty proportional lines, but as for "the Influence of Imagination in Architecture" (the subject of his lecture), this is only conspicuous by its absence. A building is worse than nothing without sculpture,—to be sure, whenever he praises sculpture, he specially excludes sculpture of the modern sort that adorns gentlemen's halls and shilling galleries,—this, he unkindly calls, "furniture sculpture,"* and he is careful to explain that what he is talking about is not "furniture sculpture," which the housemaid presumably dusts every morning; but the *real* old-fashioned thing, the "imperfect architectural sculpture" in the tympana from Notre Dame and the two porches at Amiens,—both foreign examples, of course, because an English text wouldn't suit his discourse!

In his indictment of modern architecture, Mr. Ruskin asks, "Do you suppose the front of Whitehall, a singularly beautiful one, ever inspires the two Horse Guards, during the hour they sit opposite to it, with military ardour?" "Probably not," the architect replies. "The military instinct was not in Inigo Jones's mind when he built the Royal Palace, any more than it was in the mind of the author of the 'Dead March' in 'Saul' when he wrote the 'Coronation Anthem.' But it *was* in the mind of the proud author of the figure of the Duke of Wellington at Hyde Park-corner, that your friends the sculptors have so recently smuggled away into oblivion; and the tears live in an onion that the British soldier sheds at his loss!"

"Shall we, then," Mr. Ruskin goes on, "abandon this theory of the soul of architecture being in proportional lines?" &c., &c. "Abandon it, dear sir, by all means," the architect replies; "'tis a theory of your own concoction, and none of ours. Turner would not have agreed with it, to judge by his loving portraiture of numberless of the unsculptured buildings of England." "Perhaps, you answer again," continues Mr. Ruskin, "our sculptors at present do not design cathedrals, and could not. That is merely because we have made architecture so dull that they cannot take any interest in it, and, therefore, do not care to add to their higher knowledge the poor and common knowledge of the principles of building." "That we have alienated the sculptors by our dull work is sad indeed," the architect replies, "but if there be anything in Mr. Ruskin's uncomplimentary remarks upon modern sculpture, who shall say that the sculptor might not have been earlier invited to redeem our work if only he had not, upon Mr. Ruskin's showing, made sculpture so dull that we could not take any interest in it," &c. It would appear, then, that our chances of securing the aid of the sculptor's higher knowledge in design just now is very low indeed, as the poor man has first to redeem himself. Perhaps by the time Puritan superstition about sculpture has died out as completely as it has about colour-decoration, the sculptor may have proved himself fit to come and help us! The main point is, however, the alleged absolute importance of figure-sculpture in buildings,—that is, if they are to have any imaginative expression. My short answer to this is: Knock off all the heads and hurl down all the statues at Amiens and Notre Dame, and how infinitesimal the difference would be in the general expression of the structure whose architecture they enrich. Think, also, how Westminster Abbey and St. Paul's Cathedral contrive to be expressive buildings, although they are devoid of religious sculpture—for you will scarcely call the white throng of churchyard images that crowd and shroud their walls "religious." Englishmen will, I trust, continue to credit the authors of these fine structures with something higher than bird-and-beaver craftsmanship, in spite of these captious critics. And let me add in this connection, that if bad sculpture fails to ruin the imaginative effect of fine buildings like St. Paul's and Westminster, neither can fine sculpture, of itself, contribute any general imaginative effect where the architecture itself is inherently bad. Take the west front of Wells Cathedral as a case in point. Everybody visits Wells to see the unique group of Mediæval ecclesiastical buildings there which give such a wonderful expression to the place. They also go to study the fine array of early sculptures which cover the west front of the cathedral. History is silent as to the author of this façade, but it is so poor and feeble, so deficient in all that gives expression to design, that you must ignore the mean frontispiece to enjoy the grand sculptures. The sculptures contribute nothing to the imaginative effect of the general composition, and you must take them one by one. For the honour of architects, past and present, I would fain hope that both architecture and sculptures proceeded from one hand (they are contemporary), and I would gladly present Mr. Ruskin with this façade to add to his possible list of one Northern cathedral where the "'prentice han'" of a sculptor is to be detected in the architectural design.

And now to come to close quarters with the sources of expression in architecture. But first as to the term "expression." It came into use with descriptive writing about art, and is freely applied to creative work of all kinds. Pull the word to pieces, and you get "ex," out of, and "premere," to press,—to press or squeeze out, to declare, utter, signify. Now in one sense there is hardly any object devoid of expression, if the term be taken as covering some differential *external* quality, as in a ship, or animal, or tree. But in respect of art, the word is employed in a higher sense, rather as revealing some unique *internal* quality. And here the thing signified is almost as hard to define as the flavour of a fruit or the odour of a flower. Here we mean by the word the pervading grace, the special quality of attractiveness, the unique character of poetic interest that the poem, or picture, or building has. From whence comes this poetic interest? Wherein lies the secret of its charm for us? I would explain it in this way. Art of all kinds comprehends the forms in which men of genius utter what is in them. Art is the speech of poetic minds, and a work of art acquires its poetic interest by the simple fact that the artist has pressed out of his imaginative self the master qualities of his mind, and imparted these to his work. The thing speaks *for* the man and *of* the man. Hence the adage, "the style is the man." There is always found in the work of a man of genius an emotional quality of style which gives us so much more than the outward garb of the thing. For example, you can tell by its quality of style that this or that piece of music is by Beethoven or Greig ere a dozen bars have been played through, though you had never heard the piece before.

Here we touch the supreme mystery of art, which declares the divinity of its source. The dead, inanimate material that the artist handles

* A paper by Mr. J. D. Sedding, F.R.I.B.A., read in the Section of Architecture at the recent Art Congress in Edinburgh.

* "Two Paths."

—be it a lump of clay, a stretch of canvas, a heap of stones, is quickened into life, transfigured by the man's communication of his own spirit to the thing. The stretch of dead canvas becomes sensitive and alive under Leonardo's hand, and the thing painted is immortalised: for the flesh of Mona Lisa still glows, the pulses of her neck seem still to palpitate, the carnation upon her cheek is still there, the wistful eyes still gaze out beyond the picture, beyond you, and into eternity. The face of the landscape that Wordsworth and Turner painted had nothing uncommon about it to the eye of the village yokel, but the man of genius as he paints it imparts to the picture by some subtle magic his own unique imaginative expression, and, lo! it acquires a new influence, the added gleam—

> "The light that never was on sea or land,
> The consecration of the poet's dream."

It would seem, then, that a work of art,—poem, building, or painting,—gets its singular gift of attractiveness from the personality of the man. The artist strikes the imagination of others by pressing into his work his own imaginative qualities. Sir Joshua puts the matter thus:—* "It is not the eye, it is the mind which the painter of genius desires to address." "The artist," he says, "will not waste a moment upon these smaller objects, which only serve to catch the sense, to divide the attention, or to counteract his great design of speaking to the heart; and it is this power of address that entitles painting to rank as a sister of poetry."

Now, in demonstrating to you that a great building, like a great painting or poem, has this evocative power and hold over the imagination, I cannot do better than quote two short passages from the writings of men who, though not art critics, have got a word or two to say upon this point worth listening to. "A Gothic Cathedral," says Hawthorne,† "is surely the most wonderful work which mortal man has yet achieved, so vast, so intricate, and so profoundly simple, with such strange, delightful recesses in its grand figure, so difficult to comprehend within one idea, and yet so consonant that it ultimately draws the beholder and his universe into its harmony. *It is the one thing in the world that is vast enough and rich enough.*"

So much for the English cathedral here described (that has no sculpture), as interpreted on its spiritual side by a master of spiritual analysis; and now for the charming bit about Noyon Cathedral, in Mr. Stevenson's "Inland Voyage" (p. 168–10), where the expressiveness of a fine building is well enforced:—"I find I never weary of great churches. It is my favourite kind of mountain scenery. Mankind was never so happily inspired as when it made a cathedral; a thing as single and specious as a statue to the first glance, and yet, on examination, as lively and interesting as a forest in detail. . . . . Where we have so many elegant proportions growing one out of the other, and all together into one, it seems as if proportion transcended itself, and became something different and more imposing." "I could never fathom," says Mr. Stevenson, "how a man dares to lift up his voice to preach in a cathedral. What is he to say that will not be an anti-climax? For though I have heard a considerable variety of sermons, I never yet heard one that was so expressive as a cathedral. 'Tis the best preacher itself, and preaches day and night; not only telling you of man's art and aspirations in the past, but convicting your own soul of ardent sympathies," &c.

If the witness of two writers whose minds are of the highest imaginative class be worth anything, we should have here abundant proof of the things in architecture that I am endeavouring to demonstrate,—its innate poetry, its emotional element imparted by the designer, its evocative power over the imagination of the beholder,—in a word the self-centred purpose of an art that has noble ways of utterance of its own whether allied to sculpture or not. "A Gothic cathedral is surely the most wonderful work which mortal man has yet achieved. It is the one thing in the world that is vast enough and rich enough," says one writer. "Mankind was never so happily inspired as when it made a cathedral,—a thing as single and specious as a statue,"—says the other.

We will now dwell more particularly upon the sources of expression in architecture; this will bring us face to face with the architect, and we shall realise something of the means and instruments of his art. Let it be understood that the architect is first and last a pictorial artist on a large scale. Indeed, none of the arts, except music and poetry, have the same chances of prolonged effort in design as the architect. The sculptor and painter nowadays are content with their brief but brilliant swallow-flights, but the architect's art reveals him to us as the stimulator of men's imaginations by means of large effects extended over a large area. He is a picturesque manipulator of vast forms, he deals with proportional lines, outlines, contrast, mouldings, masses, bulk, broad sunshine and deep shade. He is a subtle harmonist of the contending motives of his structure: a colourist who employs colour-artifice in material or pigment, or gets it by glints of light upon delicate tracery and broken wall-surface; to say nothing of his employment of the best colouring-matter of all—the essence of his own unique genius. In his capacity of pictorial artist on a large scale, he not only uses his own best faculties, but the best faculties of others, much as the musical composer secures the best soloists and the best chorus he can get to form the orchestra that renders his oratorio. And he takes occasion by the hand in using to the best advantage every adventitious circumstance of site or material or natural resource. The best architects of the past have been men in whom the shaping faculty has been highly developed; and though their names may have perished, the loftier masters of design come before us in history as giant forces; the technical power and originality of their design, the beauty of their detail, the range of their imaginative flight, all proclaim their work as the finest expression of human intelligence. "Many are the mighty things," says Sophocles, "and nought is more mighty than man."

But it is a mistake to suppose that a building is bound to be adorned with sculpture to have imaginative expression. A building is capable of high interest and expression with no aid from sculpture and scarcely any ornament; yet, whether severe and naked, or never so richly adorned, it is from the architect that it gets its expression. Whether only the skilled mason and carpenter have helped him, or whether he have enlisted the highest instincts of the finest natures, his mind will have anticipated every stroke that is there, the depth of frieze for the painting or sculpture, the niche or pediment for the figure,—architecture and decoration, will have been sketched by him on his drawings; all will have been seen by the architect before ever the sculptor or painter is called in to exercise his genius.

I have here tried to show you the architect at his work,—now for his stock-in-trade. In its first analysis architecture is the picturesque expression of plan and construction in a building. To speak broadly, there are two faculties displayed in the art,—invention and imagination. Invention has to do with the plan and scheme of a building and the relation of its parts; and the artist calls this faculty into play in much the same way as the dramatist creates his characters, disposes of their destinies, thinks out the course of events in his story, and sets the scenes. But in the best work invention goes no further, imagination must do the rest. The eye of the body can go so far, and the rest must be left to the eye of the mind. Having made the plan and settled the scheme of the structure, its heights and size, invention retires and imagination takes up the tale.

Out of the picturesque plan grows picturesque construction, and if it be a great building like the Parthenon, or Beauvais, or St. Paul's, or York, there is a delicate skeleton of admirably articulated parts underlying and sustaining everything; this skeleton of related parts not only fulfils its primary office of keeping the building from sinking on itself, a shapeless heap, but the various constructive features themselves are made beautiful, while they conduce to the general beauty of the whole.

It has been wrongly supposed that it is in Gothic art alone that picturesque planning is used as a source of expression. The art of all ages proves to the contrary. To take a typical Classic example, the architect of the Erectheum, as Mr. Ferguson has pointed out, took the greatest possible pains to produce variety and contrast in the grouping of the three temples of which the Erectheum consisted, and "no Gothic architect, in his wildest moments, could have conceived anything more picturesquely irregular than the whole becomes." Indeed, there can be no greater mistake than to suppose that Greek architecture was fettered by any fixed laws of symmetry. But I need not go so far afield for an illustration of expressive planning and construction. Wren's noble series of City churches afford us quite an intellectual treat in this respect, and, in order to properly gauge the dexterity of the man, you must bear in mind that the old walls of the churches that had been burnt down were in many cases left standing, to be used as the superstructure of his new buildings. St. Stephen's, Walbrook, is an example in point, where, within the limits of the four plain walls which marked the boundary of the old church, the architect has reared a nave, choir, and transept, with a dome over the intersection, and has produced pleasant effects by means of numerous columns, and the domical ceiling which they carry.

One further note of the intellectuality of Wren's work is seen in the employment of the geometrical relations between the main dimensions, of which Professor Roger Smith has recently given many interesting examples. The great importance of geometry in architectural design was a doctrine strongly enforced by Wren, and it cannot be denied that the intellectual quality of his own work is enhanced by his own practice in this respect. Whether you agree with the doctrine or not is another matter, for some may, with Sir Joshua, prefer art that is done "by a kind of felicity and not by rule"—yet one man may best speak out of his head and another out of his heart. In yet one other particular should the power of expression in Wren's work be noticed, and that is, the way in which, without the use of any religious sculpture, he can obtain religious effects.

To come now to other sources of expression in architecture. In historic art of all periods you find certain picturesque features ever recurring, such as colonnades, arcades, buttresses, recessed openings to massive walls, towers, spires, domes, mouldings, and sculptures that grow out of the mason's art. It is by the universal adoption of the same, or analogous means, to attain the same artistic results that the unity of the art is declared. The methods employed may differ at various times, yet the quality aimed at is much the same. Take, for example, the various means adopted at different times to render vastness or sublimity. At one time it is the vastness of mass in the Pyramids, and the impression of solidity and durability that they are so well calculated to give. At another time it is the vastness of the rock-cut tombs and temples (as the Elephanta rocks at Bombay) that chill your marrow with their mysterious gloom, huge columns, and colossal deities countersunk in the rock. At another, the vastness of a gigantic columnar edifice that shall give the sense of infinite space, as at Karnac; at another, the ring of monster monoliths at Stonehenge; at another, the vastness of grand scale in the Coliseum at Rome; at another, the vastness of height in the French cathedrals; at another, the vastness of proportions as at Seville, or Milan, or S. Peter's at Rome; at another, the vastness of long-drawn aisles with monotonous columns and flat roofs, as in the Italian Basilicas, or Ely and St. Albans. In most of these examples it is sheer weight and vigour of masses that is employed as an attribute of expression,—the undivided weight of solid stone, colossal scale, broad sunshine, and unrelieved gloom. The Hypostyle Hall at Karnac is one vast oblong 340 ft. long by 170 ft. wide, that has 116 huge columns, and that covers more than 88,000 ft. No artist has been able to reproduce its form, so as to convey to those who have not seen it an idea of its grandeur. A flood of light beats down from the clearstory formed by the taller central piers, and the smaller pillars fade away into deep obscurity. Or to speak of that characteristic French way of using vastness of height in those "soaring miracles of stone" at Beauvais, Le Mans, Tours, &c. And here, though this be the leading purpose of the architect's design, it is combined with other manifest attributes of mechanical power, fertile invention, and that conformity to rule which governs the constructive side of perfect architecture; while the higher and spiritual side is proclaimed in a bright imagination, noble proportions, sublime audacity, and the restless, half-sad, half-gay humour of a spirit that yearns after the unattainable.

Of other expressive traits in Gothic art it is superfluous for me to speak. It is a mistake, however, to lay too much stress upon the forms of Gothic architecture as though it was from them and not from the man who uses them that their expression comes. Hence, I suppose, the

* Reynolds's "Discourses."
† "Old Home," p. 106.

dissatisfaction with so much of modern Gothic work; the forms are correct enough, but you want the old master's soul behind them. The fact is that Mediæval art gets its romantic charm from the spirit that animated its designers. So far as mere variety of form and play of fancy is concerned Wren's spire at St. Mary-le-Bow far transcends Salisbury's spire, but the conscious art of the former, the studied harmony of its proportions, the subtleties of its fancy, are not favourable to romantic effects, it lacks the simple aspiration and *naïve* utterance of the other. The expressiveness of Gothic art is usually ascribed to the variety and contrast of its effects and to the intricate harmony of its constructive lines, such as is to be found at Abbeville, Rouen, York, or Gloucester. But to stop here were to leave the tale untold. There is a noble severity about the early phase of English Gothic, both in regard to proportion and scale, that is highly stimulating to the imagination. Think of the interiors of Durham and Peterborough, with the strange colossal scale of their features and ornamentation that hint of the sense of physical power and indomitable will of their builders. The majesty of their pregnant lines carries us back to the grand buildings of old Rome that are like vast mountains haunted with mighty shadows.

That there is more picturesqueness of plan and construction in the later work like York or Gloucester, more harmony of related parts, more play of sequent motive, than in the tentative earlier phases, was to be expected, for art "widens with the process of the suns;" and, just before the Gothic forms were forsaken, the art comes to a head in that "glorious work of fine intelligence" at King's College, Cambridge, so eloquently described by Wordsworth, with its lofty pillars, its

> * * * "branching roof,
> Self-poised, and scooped into ten thousand cells
> Where light and shade repose, where music dwells
> Lingering—and wandering, as loth to die."

Yes, Wordsworth finds architecture to be something more than bird-and-beaver craftsmanship, and his spirit is stirred by its magic, though of figure sculpture it has none. What affects him is its piquant variety of light and shade, and colour, and play of motive, and borrowed charm of personality, that makes the logic of passion and imagination in a fine building, and speaks of divinely inspired cunning. What is more, he realises that not sculpture, but organ music, will interpret the meaning, fill with expression, and make to vibrate every nook and corner of the amplest and loftiest edifices. Milton found it out before him.

Of colour as a means of expression in architecture I have no time to speak other than to point out that, where colour is the felt medium of his expression, as in Byzantine or Venetian work, the architect attempts no variety of outline or highly relieved or strongly contrasted architectural form. And the self-sufficing quality of colour as a source of architectural expression is amply illustrated in the schools of southern and eastern art just mentioned, as also in such charming architecture as the Taj at Agra, which, like most Oriental art, is bound to exclude every sign of the human form out of respect to Mahommedan prejudices. Nor may I dwell upon the expressiveness of architectural features, window tracery, or gables, or sculptured doors, or buttresses, or of sculptured screens, like Winchester and St. Albans; nor of rere-doses, nor of monuments, nor the exquisite variety of richly-adorned roofs or stone groining, nor of more general features, like towers, such as Seville, Florence, or St. Mary Magdalene, Oxford, or St. Giles, Edinburgh; nor of domes like those at St. Mark's, or St. St. Peter's, Rome, or St. Paul's, London. There is latent poetry in them all. A dome attracts from afar, whether seen across the great campagna or looming big in city smoke. You rejoice in its sense of serene power. All is calm there.

Nor, again, may I stay to dilate upon the expression that architecture can yield when applied to its site, as is notably illustrated in this grand citadel of the north, where castle and crag merge in one eminence.

But one brief word must be said in conclusion of the much-vaunted importance of sculpture in architecture, and to bring this to something of a decisive test I have reserved till now my reference to Greek art. In Greek art, is perfect architecture and perfect sculpture, perfectly applied. And in this connexion I recall how a sculptor-friend of mine—one of the too few sculptors in the Royal Academy—is wont to describe the architect as "the man who makes the box." Of course, there is an implied compliment to himself in the simile or he would not use it! Let that pass.

Now the Parthenon affords a generic example of Greek art at its height. Neither the "box" nor its images could be better made. If I now follow the fashion of the critics and compare the relative consequence of the one and of the other as found in the same structure, I feel that it is an inane thing to do. For a building, like any other work of art, is not to be judged by its several particulars, but as a whole. You should take in its expression with one sweep of your eye, its lights and shadows, its gradation of distance, its individual character.

The Parthenon has gathered into itself all the best points of Greek architecture,—it has studied harmony of proportions, delicacy of feeling in optical corrections, exquisite taste in selection of mouldings, coloured ornaments, and unrivalled sculpture. Now I took the trouble three days ago to examine Bohn's view of the Acropolis "restored," which is to be seen in the British Museum in the same room as the Parthenon sculpture; and, with all the rest of the world, I realised that the grace of the Acropolis consisted in its buildings. With the subject of this paper in mind I went further than this, and tried to estimate for myself from Bohn's careful picture, the amount of expression that the figure-sculpture dotted here and there was calculated to give. So, also, did I study the large model of the Parthenon with the same intent, and in each case I came to the same conclusion. It wasn't that there was a defect or deficiency in the sculpture, it is glorious: but that with all its loveliness and quantity it was only an accessory to the architecture.

Take away the sculpture, and some accidental grace were gone, but the building in all its transcendent beauty would remain "as single and specious as a statue." Take away the sculpture and its air of sublimity would remain in the sheer weight and vigour of its masses and in the colossal scale of its architectural forms; its air of grace would remain in the modulated harmony and exquisite perfectness of its related parts; its air of intellectuality would remain in the austere majesty of its conception; its air of religious awe would remain in the mystery and poetry that its author communicated to his work by means that he knew so well how to wield.

I spoke of the sublimity of its proportions and scale; and to be quite frank,—what a puny part must these beautiful sculptures, with the exception of the large central deity, have played, set against the vast, assertive architectural forms that hemmed them in! Think of the expressiveness of the structure as the broad rays of rising or setting sun beat aslant the clearstory in the roof upon massy columns or undivided weight of solid wall and threw the unlit parts in gloomy shade! Think of the small scale of the sculptures,—the noble frieze, for instance, is but 3 ft. 4 in. deep,—and compare this with the impressiveness of mighty mouldings and of columns whose abacus is 6ft. 5 in. square and diameter 5 ft. at the top! The young ladies who so assiduously sketch the statuary in the gallery think that all the honey out of the hive of the structure is here in this purloined imagery. But we know better. It is the glory of a great building that it is one grand indivisible whole; take away its sculpture and some accidental grace is gone, some emphasis of parts is lost, but the primary quality, the central sweetness of the thing remains. On the other hand, if a structure retains its expression, even though you remove its accessory of figure-sculpture, 'tis different with the sculpture that is so removed. The figures formed part of the very masonry of the structure. They emphasised its parts. The glory that they had was a communicated glory. The music that they made was only a part in a grand chorus—a share in the pervading harmony of the fabric that the master-musician had blended with the melody and rhythm of the rest of the related parts. The music was not theirs, for it would go on still in the fabric and with little perceptible difference when the figures are gone. But removal makes all the difference to the figures; their inherent loveliness remains, but they become—in a manner—dumb. Remove them from the pediment, or pedestal, or niche, to which they were allied, and they wear an orphaned look like poor casuals without a home; happy if your friendly Britisher find them a corner in a stuffy museum where daintily-dressed Slade students may portray them in chalk or charcoal four days a week.

Here I break off. I shall be right glad if, in my disjointed way, I have done something to illustrate the true dignity of architecture as a poetic, self-expressive art, with noble ways of utterance of its own that render it independent of the sister arts as at present constituted. And yet, I may not forget that there is something even better to contend for than the honour of one's own art, and that is—the welfare of the great commonwealth of art. I trust, then, that in my endeavour to brush away some of the critic's cobwebs that hinder a true conception of architecture as it really is, I have let fall no hasty word to hurt the sensibilities of any one here present, or to impair the chances of more cordial relations between architect, sculptor and painter, which it is the one great desire of my heart and the purpose of my life to promote to the utmost of my power.

THE ROYAL INSTITUTE OF BRITISH ARCHITECTS.

A BUSINESS general meeting of this Institute took place on Monday evening last, Mr. John Macvicar Anderson (Vice-President) occupying the chair, in the absence of the President.

Mr. W. H. White (Secretary) intimated the decease of the following Fellows, viz., Mr. William Millican, J.P., of Leicester, and Mr. Harry Robert Newton, of Weybridge.

Mr. White also announced that the Architectural Union Company had presented a donation of twenty-five guineas to the library for the purchase of books. It was stated that, in the following Thursday's "Journal of Proceedings," a long list of donations to the library would be published. Votes of thanks were accorded to the several donors.

The Church of St. Mary-le-Strand.

The Chairman said that at the last meeting the subject of the Church of St. Mary-le-Strand was referred to, and a desire expressed that, if possible, the church should be open for the inspection of members of the Institute, or of those of the public who might be interested in its restoration. He had accordingly communicated with Canon Tugwell, who had made arrangements so that the church would be open for the inspection of members of the Institute and their friends daily for one week from the 20th inst., between the hours of ten and four (applause).

Election of Members.

A ballot was then taken, when the following candidates were elected as Fellows, viz.:—John Edward Sears (Associate), Frederic Richard Farrow (Associate), James Herbert Stones (Blackburn), Arthur Wells (Hastings), Joseph Barker Daniel Wall (Associate), Hildebrand Attwood Wooster Reeves (Associate), Delissa Joseph, John Clarkson (Associate), Charles James Dawson, James Edward Clifton (Swanage), Frederick William Ridgway (Associate), Dewsbury; Albert Edward Murray, Hon. Secretary of the Royal Institute of Architects of Ireland, Dublin; John Howard Pentland, B.A., B.E., P.W.D., Dublin; John Tweedale (Associate), Leeds; Richard Mauleverer Roe (Associate); William Henry Syme (Associate), Watford; and Herbert Walker (Assoc.M.Inst.-C.E., Nottingham).

The following gentlemen (who had passed the examination for entrance) were elected Associates upon a show of hands, viz.:—Messrs. Herbert Lingard Whitley, Gilbert Wood (Southsea), Ravenscroft Elsey Smith, Bertram Norman Southall, Henry Vaughan Lanchester, George Kenyon.

The following gentlemen were also admitted as Hon. Associates, on a show of hands, viz.:—Colonel Samuel Swinton Jacob, Bombay Staff Corps, Engineer to the Jeypoor State, Jeypoor, Rajpootana; John Dibble Crace, 15, Gloucester-place, Portman-square, W.

The Application of Iron and Steel to Building Purposes.

The second ordinary meeting of the session was then held, when a paper was read by Mr. Frederick T. Reade, Assoc. M. Inst. C.E., hon. associate, entitled, "The Application of Iron and Steel to Building Purposes." The following are extracts from the paper:—

After a brief introduction, and having dealt with the question of foundations and piers, Mr. Reade said that as the greater part of the ques-

tion discussed had to do with weights to be supported, it would seem to be proper to begin with the subject of columns and stanchions and their foundations.

The results of many experiments showed that two tons load per superficial foot of foundation was a safe limit to assume for ordinary clay, gravel, &c. Having settled on a limit of pressure on the earth, we will now consider the question of an isolated column as being the simplest case, and will assume that it carries a not unusual load of 50 tons; such a column would weigh about 15 cwt., say one ton; thus 51 tons will be discharged on its bed stone. This bed stone may be taken as ordinary sandstone, which would carry with safety a load of 25 tons per foot; this determines the size of base flange of column, which in this case should have an area of two feet at least. In a building where the ground-floor supports are principally columns, and especially for a corner shop where there is only a party and back wall, it is advisable to make the column or stanchion bases larger than given by above rule to give lateral steadiness to the building. The concrete block under the bed stone or base plate or brick pier should always be mixed with Portland cement, for the ordinary lime concrete is long in setting, and in large masses it will take years before the centre of block becomes hard. One of Portland cement to eight of other ingredients, if carefully and well mixed, will safely bear a load of 5 tons per superficial foot. These other ingredients should be *hard* materials, as gravel, broken stone and bricks, or bats of hard quality.

Cast-iron Columns and Stanchions.—A cast-iron hollow column to carry 50 tons should have a ratio of about fifteen to twenty times its diameter for its length; this might safely be loaded to 2½ tons per square inch of sectional area; and, if we assume a diameter of 9 in., and a thickness of metal of 1 in., we get an area of 25 in., 20 per cent. in excess of our requirements; but for hollow columns it is always advisable to have a liberal margin of safety, as, unless great care is taken in the moulding, the shifting of the core may cause an unequal thickness of metal in the casting. The hollow column is, theoretically, the strongest form of section, but the probability of an unequal thickness of metal is an objection to its use; this may be guarded against, to a certain extent, by specifying that some of the columns shall have small holes drilled in their shafts to ascertain the thickness, and that, where the metal on opposite sides differs more than one-fifth of the proper thickness, such columns shall be broken up. Another objection to the form of the hollow column is that it does not lend itself very readily to being cased in a fire-proof material. We will assume, however, that a hollow column has been decided on for our present example to carry 50 tons. The size of its base flange has been already given, and it should have a bold rounding at its junction with the shaft, and bracketed in four directions; the thickness of the base flange should be from one-eighth to one-quarter more than the thickness of the shaft—in this case 1¼ in.

It will often be found that stanchions of the + or H section are preferable. They have this great advantage, that the whole surface of the metal can be seen, and any imperfections detected; also the absence of the central core greatly reduces the risk of an unsound casting, while in tiers or stacks of stanchions such sections give great facilities for making simple junctions of girders and iron joists at the various floor levels. In designing a stanchion of H section to be placed flat against a wall, it must be remembered that the least width of its section,—viz., the width of the flange of the H section, is the measure of its strength, and it will be seen at once that an H section 12 in. by 6 in. is not so strong as one 12 in. by 9 in., even though it contained the same sectional area. The commonly employed ⊓, or ⊓ section, is not to be recommended, on account of the very unequal distribution of compressive stress over its section, and also on account of its liability to become bowed in cooling,—a risk which, more or less, attends all very non-symmetrical sections. These channel sections are generally fixed with the web, or back, placed against the wall; but the stanchion is under better conditions if the web is placed outwards towards the centre of the span. Whatever form of section of column or stanchion is decided on, it is important that the cap-plate on which the girder rests should be well chamfered back from the front to prevent the girder from bearing on the extreme front edge of the cap-plate, and in the case of very narrow stanchions the cap-plate should also be narrow, to prevent as far as possible the deflection of the girder tending to bend the stanchion.

All bed-stones for ends of girders in walls should have their front edges chamfered in the same manner, and for a distance of 3 in. from the face.

Wrought-iron and Steel Stanchions.—It is not now uncommon to use stanchions made of rolled joists, the cap and base plate being fixed to the joists by angle-irons or gusset-plates, or both combined. As the ends of joists cannot be considered as bearing accurately on the end-plates, without special care in the workmanship, such gussets and angles must be designed so that the shearing or bearing resistance of the riveting alone is sufficient to transmit the load to the base flange. For very heavy loads,—say 150 to 300 tons,—it is usual to make stanchions of wrought iron, of tubular section, with web plates and angle-iron, or with webs made of rolled joists or channel irons. The construction of such stanchions presents many special difficulties of design in the cap and base junctions; and, as such loads rarely occur in ordinary practice, it is advisable, whenever they do occur, that an engineer should be employed to design them.

Cast-iron base plates direct on concrete are rarely used, unless the load on the column exceeds 100 tons. It is not possible to give a rule for their depth in centre, or the thickness of metal, as this will be influenced by the number of the radiating arms and their thickness; but a rough approximation would be 2½ in. in depth for every foot in diameter, and a nearly uniform thickness to that of the column or stanchion on it. Thus, a base plate 6 ft. diameter would be about 15 in. deep in the centre, and as the stanchion on it would have to carry a load of 130 tons, it would be found to work out to about 1¾ in. metal, and base plate should have the same thickness. Such a base should have some holes about 3 in. diameter cast in the spaces between each pair of radiating arms, so that when the base plate is wedged up, and cement is run under the same, it can be seen to flow at these holes, and thus make certain that the whole area of the plate is covered by cement.

Cast-iron Girder.—Cast-iron girders are now so rarely used that it will not be necessary to devote much time to their consideration; they should never be used for great or variable loads, and their proportion of depth to span should rarely be less than one-twelfth. They may be used with advantage for carrying window-backs between cast-iron stanchions in light areas in interior of buildings, or in fronts which are constructed of iron stanchions and very little brickwork. In such cases their span would rarely exceed 10 to 12 ft., and their load would only be one 9 in. window back and half a bay of wooden or concrete floor,—probably not exceeding a total of 6 tons distributed. It generally happens that although, theoretically, the top flange need only have a small area, yet, practically, to carry 9 in. brickwork, it has to be of such width that, to comply with the theoretical conditions, its thickness would be very small compared with the rest of the section.

For practical reasons, it would be unsafe to have much difference in the thickness of metal, and it would not be advisable to make the top flange less than ⅜ in. thick, the web to taper downwards. Thus, supposing the bottom flange was 1 in. thick, the web might be ½ in. at bottom and ⅜ in. at the top, with bold corners or mouldings in angles where joining top and bottom flanges; vertical ribs or stiffeners should be put between top and bottom flanges, about 36 in. apart; and, as the material gives facilities for treating these ornamentally, they can be moulded on the face and at the ends. The ends of the girder can be easily cast so as to make a neatly-fitting junction with the stanchion, and in a way almost impossible to treat in wrought-iron.

Wrought-iron and Steel-rolled Joists.—In considering the question of wrought-iron girders, it will be best to begin with the simplest forms, which may be taken to be rolled-iron joists. Lists of their sections and safe loads must be in the hands of most of the members of this Institute; but your attention should be directed to the variation in the amounts of the safe loads given in these lists by manufacturers and dealers in rolled joists. They very rarely give the limit of stress per inch on which such sections are calculated, and this accounts for the discrepancies which have doubtless been noticed between different lists, in which joists of identical sections have safe loads appended to them, which in some cases vary nearly 25 per cent., the reason being that the smaller load has been calculated for a stress limit of 5 tons per inch, while those showing heavier loads have been taken on a limit of 6 or 6½ tons per inch.

Compound Girders, or Rolled Joists with additional Flange Plates riveted on.—A very useful and economical form of girder can be made in this way, and the mode of calculating its strength or sectional area is identical with that given for wrought-iron girders further on, with this difference, that, considering the inferior quality of the material in rolled joist flanges, the limits of stress for these sections should not exceed five tons per inch of sectional area, and, in calculating this, only one rivet-hole need be deducted from the joist flange, the holes not being placed opposite to one another. The greater part of the flange section being usually in the joist itself, fewer rivets are required to attach the plates than in a built-up girder. If only a single plate top and bottom is used, ⅞ in. rivets at 8 in. pitch placed zigzag will suffice. The holes for rivets in the joist should always be drilled, for the iron in the flanges must necessarily be under worse conditions than the rest of the metal in the joist; and I have often seen cracks in rolled joist flanges extending from the rivet-holes to the edge, the strength of girder being diminished thereby to the extent of 10 to 20 per cent. Heavy-section rolled joists carrying loads not exceeding 20 tons may sometimes have their attachments made to columns, by bolting the webs to lugs cast on the columns; but in the case of heavier loads, and nearly always in the case of compound girders, vertical angle irons should be riveted on each side of ends of web, partly to act as end stiffeners to it, and partly as a means of making a more reliable connection to the column or stanchion.

Wrought-iron and Steel Riveted Girders.—The process of calculating the strength and designing the section of a girder must now be briefly described. The span of a girder,—for calculation,—is the distance between the *centres* of its bearings, its depth is the depth between the centres of the sectional areas of the flanges,—and in ordinary girders of angle-irons and plate-flanges it is usual to take the width of the web-plates as the depth for calculation, and it is important that this should not be a very small fraction of the span; if less than $\frac{1}{10}$ it will either have extreme deflection, or be wasteful by excess of material in the flanges; or, if more than $\frac{1}{10}$, we shall probably have an excess of material in the web itself. A practical illustration being more useful than a bare statement of rules, we will suppose a girder has to be designed, of 20 ft. span, to carry a load of 30 tons, equally distributed over its length; we will assume that the circumstances of the case allow of almost any depth, and as the limits of $\frac{1}{12}$ to $\frac{1}{10}$ of the span have already been given, we will take the mean, or $\frac{1}{15}$ of the span, which is 15 inches; this will be the depth of the girder between the inside of the flanges, which in an ordinary girder may be considered as the centres of the sectional areas. The first thing to be determined is the measure of the effect of the load, or what is called the bending moment; in other words, the load in tons multiplied by the span in feet and the product divided by 8 for distributed loads, or 4 for a central load. As girders are all levers of one sort or other, and the principle of the lever is well known, it is not necessary to explain the divisors 8 and 4. $\frac{30 \text{ tons} \times 20 \text{ feet}}{8} = 75$ foot-tons.

This is the effect of the load or greatest bending moment in the centre of the span, and we now have to find what section of girder is required to resist it, or the moment of resistance. We have fixed the depth at 15 in., and will suppose the material is to be wrought iron. If the load assumed above is a dead load—that is, a solid mass of brick or stone wall weighing 30 tons—the limit of stress for the material named should not exceed 5 tons per inch. If it were a mixed load—say, 15 tons of dead weight and 15 tons of floors which would never be completely loaded over whole area—part of the floor-load becomes hypothetical, and we may increase the limit of stress to 6 tons per inch. The latter case being the most usual condition, we will take 6 tons. The moment of resistance will then be the depth in feet, equal 1¼, multiplied by the limit of stress, 6 tons, multiplied by the sectional area of one of the flanges. As the moment of resistance has to be equal to the bending moment,

the required area of the flange will be the bending moment, or 75 tons, divided by 6 tons limit of stress multiplied by $1\frac{1}{4}$ ft. depth, or

$$\frac{75}{6 \times 1\frac{1}{4}} = 10 \text{ in.};$$

this is the net sectional area of the flange, after deducting rivet-holes. It was formerly considered necessary to make the top flanges of wrought-iron girder stronger than the bottom, but the general practice is now to make them equal, except under special circumstances, as, for instance, bridge or roof girders where the top flange has no lateral bracing or other support. Most of the calculations for a girder can be determined by the rules of graphic statics, and you will find the modes of doing this very clearly and simply described in two books on "Strains in Iron Work" and "Designing Wrought and Cast-iron Structures," by H. Adams, published by Messrs. Spon. In designing girders beyond 30 ft. long, and with flanges built up of several thicknesses of plates, it is necessary to make the plates in such lengths that their weight shall not exceed the limits allowed by the ironmakers. This limit of weight may at present be taken at 6 to 8 cwt., and the limit of area at 30 ft.

It is of the utmost importance that all riveting should be done in the best possible manner. The "snap" or end of the rivet, which is hammered out while red hot, should project uniformly all round the diameter of the rivet; they should be of uniform size, and any of them showing radiating cracks, or being of a size much smaller than the others, should be condemned; also, wherever countersunk rivets are required for bearings, &c., the plates or angles should have the rivet-holes countersunk by the drilling machine, and show on the outside at least $\frac{1}{8}$ in. to $\frac{1}{4}$ in. larger in diameter than the size of the rivet-hole. It is a very common practice to trust to the taper given to the holes in the process of punching, and so save the small additional cost of countersinking. This cannot be too strongly condemned, as such rivets are often loose in the hole, and thus doing no work. It is easy to detect such loose rivets by placing the finger on the snap or countersunk end, and lightly tapping the head with a hand hammer; the movement of the rivet in the hole, if loose, is immediately detected, and they should be cut out and replaced by new perfect rivets. The process of designing a girder in steel is exactly as above described, except that a higher limit of stress is introduced into the calculations, it now becoming 7 tons for a dead load, and $8\frac{1}{2}$ tons for a mixed load of floors and brickwork, or floors only. It is not advisable to make the webs of steel girders as thin as the increased strength of the material would seem to render possible, except in girders of dimensions much beyond our present example. In the rivet-holes in both materials it is usual in good work that all holes should be drilled; but in *steel* girders of any description this *must* be done, for the effect of punching upon the steel is to weaken the metal for a certain distance round the hole. This is sometimes remedied by punching the holes to about $\frac{1}{4}$ in. less than the diameter of the rivets, and then drilling out the holes to the larger size.

I may mention an adaptation of iron to the purposes of shoring. It is very useful in the case of an opening requiring to be cut through a wall at such a height above the ground level that ordinary wood shores and needles would be costly, and also prevent business being carried on in the lower storeys during the alterations. Rectangular frames can be constructed of rolled joists or channel irons, connected at the corners of frames by tightly-fitting bolts. The upper and lower members of the frames are then passed separately through small openings in the wall, and the vertical sides bolted up to them on opposite sides of the wall. The weight of the wall above can then be taken up by the frames by wedging or other adjustment, and the portion of wall between the upper and lower members of the frames cut away for the insertion of the girder or girders.

The phrase "builders' ironwork," which has unfortunately now become almost a trade term, cannot be too strongly condemned; it is used to designate an inferior description of work which is considered good enough for ordinary buildings; of course, where, as in buildings generally, the constructional ironwork is usually covered, the fine finish to girder work, such as planed edges of plates, is perhaps superfluous, except where flanges of girders are to be visible; but it cannot be too strongly insisted on that in other respects,—such as good riveting, careful jointing, and good fitting of vertical web stiffeners, &c.,—there is quite as great a necessity for good workmanship and materials in ironwork for buildings as in the best description of railway and bridge work, the loads to be carried being, in some cases, much greater than for many railway bridges.

The Chairman, in inviting discussion, said that Mr. Reade had, in a very able and exhaustive manner, treated a subject which could not fail to be of great and vital interest to practising architects. The observations in regard to girders were especially worthy of attention in these days of fire-proof floors, and when sections were recommended so light as to make one tremble. Mr. Reade had mentioned that in some instances a section was recommended $\frac{1}{20}$th of the span, so that in a span of 40 feet there would be a girder 1 ft. deep. He hoped that as so many practical men were present an interesting discussion on the paper would take place.

Mr. Robert Walker said he could fully endorse every word that had fallen from Mr. Reade as to defective ironwork. He could not imagine a more serious fraud, a more wicked imposition, than those which were perpetrated day by day by certain manufacturers of what might be termed "rotten" ironwork. Not only were joists being rolled, in Belgium and other countries, which were totally insufficient for the loads they professed to carry, but, at the same time, castings were being made which were quite unfit for the purpose to which they were devoted. Those who walked about the suburbs of London would observe corner shops with columns at the corner, such columns being often cast from the very worst iron. He believed that architects failed to realise the serious importance of using great care in the erection of cast and wrought iron work, and he felt that many catastrophes that had happened of late years might be attributed to the fact that the contact between the architectural construction and the iron construction had not been properly carried out. It was singular, so little was ironwork construction considered by the profession or the legislature, that in the Metropolitan Building Act and its amending Acts, ironwork was practically ignored. When an architect was brought in, either as consulting architect or as District Surveyor, he had little control over the ironwork, except that of being sometimes able to condemn it. They, as architects, could never pretend to be engineers, and it would be a deplorable thing if they attempted it; but the more they associated themselves and worked in unison with the engineers, the better it would be for both parties. The section-cards sent round by the various iron manufacturers were wretched things, and he would, therefore, advise the architect to put in his specification a strong test-clause, to the effect that certain sections should be cut out of the ironwork at any time, sent to Mr. Kirkaldy, and tested; and that if these did not come out satisfactorily the ironwork should be rejected. If possible, the architect should always get the ironwork to be supplied by firms of good reputation, and the only safeguard the architect could adopt was to insert such a test-clause as he had mentioned. As to using ironwork for the purpose of shoring, Mr. Reade had lately assisted him in a considerable undertaking in the City, where they managed to shore up a building, with a large number of people carrying on work all the time, so that by the assistance of heavy timber tripod shores, and rolled joists, the whole building was lifted on steel wedges. The result was that there was not a single settlement or crack in the place. Mr. Walker concluded by proposing a cordial vote of thanks to Mr. Reade for his excellent paper (applause).

Professor Aitchison, R.A., briefly seconded the motion.

Mr. T. H. Watson asked for some information as to what the material called steel was. They had a rough opinion as to what cast iron and wrought iron were, as they were accustomed to deal with them. Steel, however, was now being put forward, and he certainly had no means by which he could distinguish it from wrought iron.

Professor Kerr added his testimony to the great value of Mr. Reade's paper, and when it was published in full detail, he believed the members of the Institute, and more particularly the younger members, would find it exceedingly interesting and profitable reading. He thought that architects might recognise, without false delicacy, and as practical men, the distinction between the work of the engineer and that of the architect in iron. The time had gone by for architects pretending to know everything; in fact, they had to know a great deal too much. It was impossible for the human mind to overtake a vast range of exceedingly difficult matters, and they might, therefore, fully endorse the suggestion that when any architect had to construct a building in which there was a great deal of ironwork, he need not be ashamed to own that he had consulted an engineer. Indeed, he would venture to suggest that the architect who did not do so would make a mistake. One point that had struck him, in the little experience he had had of the matter, officially or otherwise, was this, viz., the essential, the almost more than essential importance, so to speak, of perfect precision in fixing. He had seen instances of ironwork giving way, with the result that people had been killed, and invariably, he might say, the accident had arisen from imperfection in fixing, more particularly when the engineer or smith supplied the ironwork by contract, and the builder had the fixing of it. That was a very objectionable system, as the builder often had no idea of the necessity for precision, thinking that if he laid his joists in a hole in the wall it was all right. He wished that Mr. Reade, in revising his paper, would consider whether he was perfectly right in saying that in a stanchion of the H section the measure of the strength was the sectional area of one of the flanges. He (the speaker) should say that the measure of strength was the sectional area within the extremities of the two flanges that were capable of being bent sideways; because an upright stanchion, or pillar of any sort, must be looked at as being precisely in the circumstances of a beam that was loaded on its back. He, therefore, would ask Mr. Reade whether he would not modify the phrase he had made use of?

Mr. Reade: I meant "flanges," clearly.

Professor Kerr continued that, in one of the authorities, it was stated that the accident of one side of a hollow column being thin, and the other side thick, did not affect its strength. The reason for that assertion was that so long as the proportion between the thin side and the thick side of the column was in accordance with the proportion between the top and bottom of the flange, provided the column was going to bend in the right direction, there was no harm done (laughter).* Of course, they would be inclined to insist that a column ought to be equally thick all round. There was another point he would like Mr. Reade to consider, and that was in regard to calculating the loading of floors. An old and esteemed member of the Institute,—Mr. James Knowles,—frequently made use of a very remarkable axiom, viz.,—"don't build strong, but stronger than strong." That was a remarkable dictum, but one which could not be too strongly impressed upon young architects. Mr. Reade, in some of his phrases, would lead the unwary to suppose that they were not to calculate upon all the floors being fully loaded. His own experience led him to believe that that would be a highly dangerous assumption. He believed Mr. Reade had said that, probably in no case would all the floors be fully loaded, and that, therefore, an allowance could be made for some of them not being loaded fully. But if safety were the great desideratum, Mr. Reade would withdraw that suggestion, which seemed to be a somewhat dangerous one. Many architects were so hard driven by parsimonious clients that the temptation was strong to save every penny, but it ought not to be saved in the ironwork, and by making only partial allowance for the loading of floors. Professor Kerr concluded by again expressing his opinion of the extreme value of the paper.

Mr. J. Tavenor Perry said he thought that

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* The passage referred to appears to have been a rather extraordinary reference to Hodgkinson in Gwilt's "Encyclopædia";—"Hodgkinson noticed in hollow pillars above thirty times as long as their diameter, that although the pillars were generally thicker on one side than the other, yet in bending the compressed was always the thinner side; and as cast-iron resists compression with above six times the force with which it sustains tension, no danger resulted from this almost unavoidable difference of thickness." The next editor of Gwilt had better give his attention to this, which certainly requires modification. Hodgkinson appears to have assumed that the bending stress would always take effect towards the thinner side; but an unequally imposed load might tell a different story.—Ed.

the architect should not specify any particular manufacturer of ironwork, but rather rely on the tests he put in his specification.

Mr. Cole asked what words should be made use of in ordinary specifications in regard to steel for joists and girders? And could Mr. Reade assure them that steel joists were to be had in a reliable form? He had been told that a large number of steel joists had recently been made which were very unreliable.

The vote of thanks, on being put to the meeting, was carried by acclamation.

Mr. Reade, in his reply, said Mr. Walker had pointed out that the Metropolitan Building Act practically ignored the question of ironwork, and that the District Surveyor could not interfere. He could only hope some of those who were District Surveyors would, perhaps, in time obtain some recognition of ironwork, so that there should be supervision over it. It had been suggested that he should give some description of steel. That was a very difficult point for him to say anything upon, because it was impossible to distinguish between a piece of iron and a piece of steel without making a chemical analysis, or testing their elasticity and ultimate tensile stress. The only chance of being able to detect steel would be to notice if it were finer in grain, and appeared to have a closer and denser surface outside. When fractured it would also be found much finer than iron, but there was no reliable test, and even an old expert might be deceived. He had seen a piece of wrought iron broken by repeated short blows at one end, showing a most beautiful silky fracture which would justify one in saying that better iron could not be had, and yet another piece might be broken off at the other end which appeared to be a mass of large crystals, and looked like cast-iron. Professor Kerr had been good enough to approve of the paper, and he agreed with the Professor as to the necessity for the engineer being consulted on such occasions (applause). He also agreed with Professor Kerr in his remarks about the scandalous way in which some iron was fixed. A builder, in fact, should never be permitted to do the fixing of ironwork—especially if there was anything to be done in connexion with the drilling for bolts. He had seen ¾-in. bolts put into holes where 1¼-in. bolts should have been put, so that they were as nearly as possible drawn through the holes. Professor Kerr had stated that in some book unknown it was said there was no difference in the strength of a hollow column if the thickness of metal in it differed. If the force tending to bend the column could be brought exactly to bear on that side which was strongest, it would be all right, as the thin side would then be in tension, and the thick side would resist. But if the force operated the other way, the column would go. Mr. Perry thought it injudicious to mention the name of any firm in a specification, and he quite agreed with him, because people might then say that the architect had some interest in the recommendation. What he wished to suggest was that the architect should reserve to himself the right to reject any firm of whom he did not approve.

The Chairman then intimated that the next meeting would be held on the 2nd prox., when a paper would be read by Mr. R. Elsey Smith, Associate, on "A Tour in Greece and Cyprus in 1888, as Greek Travelling Student."

The Monument to the Emperor William. The committee appointed to adjudge upon the designs for the monument to be raised in Berlin in memory of the late Emperor William has awarded the first prize to the joint competitors, Messrs. Wilhelm Rettig & Paul Pfanu, and the second prize to M. Bruno Schmitz, all Berlin architects. The four other prizes were awarded to the following sculptors:—Hildebrand, of Florence; Hilgers, of Charlottenburg; Schäfer, of Berlin; and Schilling, of Dresden. The architects have, therefore, been victorious in this keen contest.

The Hamburg Exhibition.—The recent Craft and Industrial Exhibition in Hamburg appears to have been a great success, having left a surplus of 800,000 marks. Of this sum 100,000 marks will be used in extending the Industrial Museum.

A Wagner Monument at Leipsic.—The plan of erecting a monument to Wagner at Leipsic has been revived, the well-known Berlin sculptor, Schäfer, having been commissioned to furnish the design. It will stand near the house where the composer was born.

Illustrations.

COMPETITION DESIGN FOR ROTHERHAM MARKET HALL.

THIS design was submitted by Messrs. Mitchell and Butler in the recent competition for a new market hall at Rotherham. The sum to be expended was very limited in amount, and therefore it was necessary to keep the building plain and simple. The principal front has shops on the ground floor, with a gallery over opening into the market behind. The arrangement of the market was largely determined by the position of the foundations of a former building destroyed by fire; some of the old walls being incorporated in the new work. The roof was in three equal spans running the whole length of the building, the market being entirely lit from above. The site had a considerable fall from end to end.

The drawing from which this view is taken was exhibited at the Royal Academy Exhibition of this year.

THE CHURCH OF ST. JOHN, STANSTEAD-MONTFICHET.

WE gave a general view and description of this church in the *Builder* for August 10. The present illustration, showing the tower and the west end, is from a drawing which was in the Royal Academy Exhibition of this year. Mr. W. D. Caroë is the architect.

CLAYBURY ASYLUM.

THIS building, now in course of erection at Woodford, in Essex, was commenced by the Middlesex magistrates as a fourth Asylum for the old County of Middlesex, but on the passing of the Local Government Act, 1888, the site and foundations then in progress passed to the London County Council.

The site comprises an area of 270 acres, being part of the old Claybury Hall estate, beautifully situated on high ground, 230 feet above the Ordnance datum, and commanding an extensive view over the valley of the Thames. Part of the land is charmingly wooded, affording shaded walks for the patients. No better site could be found for such a building, and although only 1½ miles from Woodford Station, and 6½ miles from the Tower Hamlets, from which district it is expected most of the patients will be sent, the Asylum will be perfectly secluded, and comprise in its own grounds all the beauties of an English rural district.

The original design was prepared in competition in 1887, when seven architects of experience in asylum planning were invited to submit designs; six were sent in, and the one prepared by Mr. G. T. Hine, of Nottingham, was selected.

The original design, made two years ago, is, in respect of its general arrangement and accommodation, almost identical with the ground-plan to which we devote one of our double-page illustrations; but some of the blocks occupied by patients were somewhat amended in point of detail when submitted for the approval of the Lunacy Commissioners.

The building is designed to accommodate 2,000 patients, 1,200 females, and 800 males, the former occupying the eastern side of the buildings, and the latter the western, while the administrative department, the kitchens, stores, laundry-buildings, recreation hall, and chapel, occupy the centre, and are flanked east and west by two central corridors which communicate with the main corridors leading to the wards in such a way as to allow access from either male or female side to all the central buildings and offices without allowing the two sexes to come into communication.

The Asylum is placed on the summit of a hill, from which the ground slopes on all sides,—the knob at the top has been sliced off to form a level plateau twelve acres in extent, on which about two-thirds of the entire buildings are erected at one uniform ground-floor level, from which the outer main corridors slope off, generally to the outside blocks; but these in no case exceed 5 ft. in depth below the ground-floor of the main building.

The buildings comprise, in addition to the patients' blocks, large workshops for males, and laundry buildings and sewing-rooms for female workers; a general store, a bakery, a large kitchen, with ample sculleries and larders, a recreation-hall capable of seating 1,200 people, and a chapel with 850 sittings.

To the east of the chapel is a residence for the Medical Superintendent, and on the west is the main-entrance block, containing Board and Committee rooms, offices for the staff, and on the first floor sitting and bed rooms for three Assistant Medical Officers; while in a separate building on the north side are rooms for two more Assistant Medical Officers.

Flanking the administrative centre are blocks for the attendants and nurses, comprising large mess and day rooms, with bedrooms on the first and second floors; and a similar building on the north side gives further accommodation for nurses and female officers, one wing being set apart for night nurses. These three blocks give sleeping accommodation for 108, while in the patients' blocks are private rooms for 120 additional attendants, and it is expected that a further number of married male attendants will reside out of the Asylum.

A separate residence on the north side is provided for the steward, and an Isolation Hospital for twenty patients (not shown on the ground plan) will be erected at a little distance from the main building.

The total accommodation of the asylum, including patients, nurses, and attendants, and the medical and other staff, will be nearly 2,250.

The building is erected north and south, nearly all the day-rooms occupied by patients having more or less a southern aspect. By the oblique arrangement of the outside corridors the front buildings do not interrupt the view from those behind.

The dormitories are planned on hospital principles, all having cross-ventilation, so far as is possible, by opposite windows.

The heating and ventilating of this building will be in itself a work of considerable magnitude, and has involved great consideration and labour in planning, having been designed in all its detail by a leading firm of engineers under the direction of the architect.

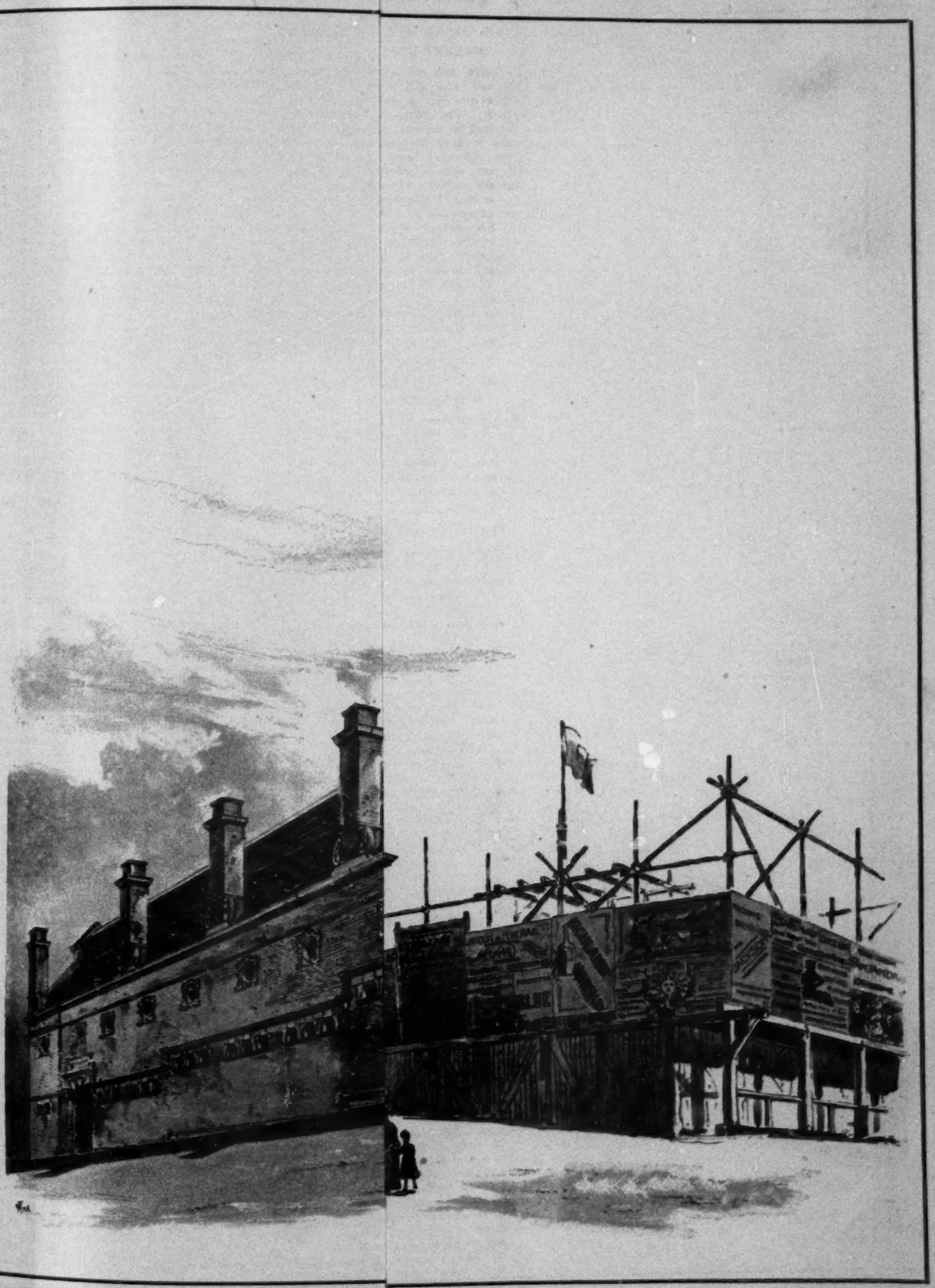
The system is one of hot air warmed by batteries of steam pipes in heating chambers in the basements of the various blocks, the fresh air being conducted to the batteries by underground trunks, and ascending directly from the heating chambers by air-flues built in the walls, one or more flues opening into every habitable room in the building. In addition to the inlet-flues are extraction-flues of corresponding area conveying vitiated air from each room to air-trunks and vertical shafts, with extraction-cowls in the roof spaces, coils of steam pipes being introduced at the base of each extraction-shaft so as to create a current.

The steam for heating the entire building, also for driving the laundry machinery, and for cooking purposes and hot water supply, is generated in a series of boilers on the north side of the building. All the main corridors are constructed with subways below for containing steam, water, and other piping. These main subways measure in the aggregate nearly a mile in length, there being another mile of subsidiary subways in the basements of the various blocks.

The best idea of the magnitude of the Asylum may be conveyed by stating that the actual buildings, including only the *interior* courts, cover an area of over twenty acres; that the main corridors measure about one mile in length; that eleven miles of underground piping will be required in the sewerage and rain-water systems, and twenty-two millions of bricks in the construction of the buildings above the ground floor line, between five and six millions having been already used in the foundations and subways, and that the weight of materials required for the construction of the superstructure is estimated at about 150,000 tons.

The building has been designed with every precaution against fire, the construction of all staircases, corridors, and connecting passages being fireproof, and the whole of the roofs of buildings occupied by patients being cut off from the rooms below by fireproof ceilings; the staircases are arranged to allow of two escapes from each ward, so that should a fire break out in any part of the building it would be impossible for a patient to be cut off from escape. In addition, a special service of water mains for fire with hydrants is provided, so as to command every part of the building, both inside and out.

The contract for the superstructure is let to Mr. Gabbutt, of Liverpool, the amount being 337,945*l.*; the foundations, subways, and casements having previously been put in, which with the levelling of the site and the erection of



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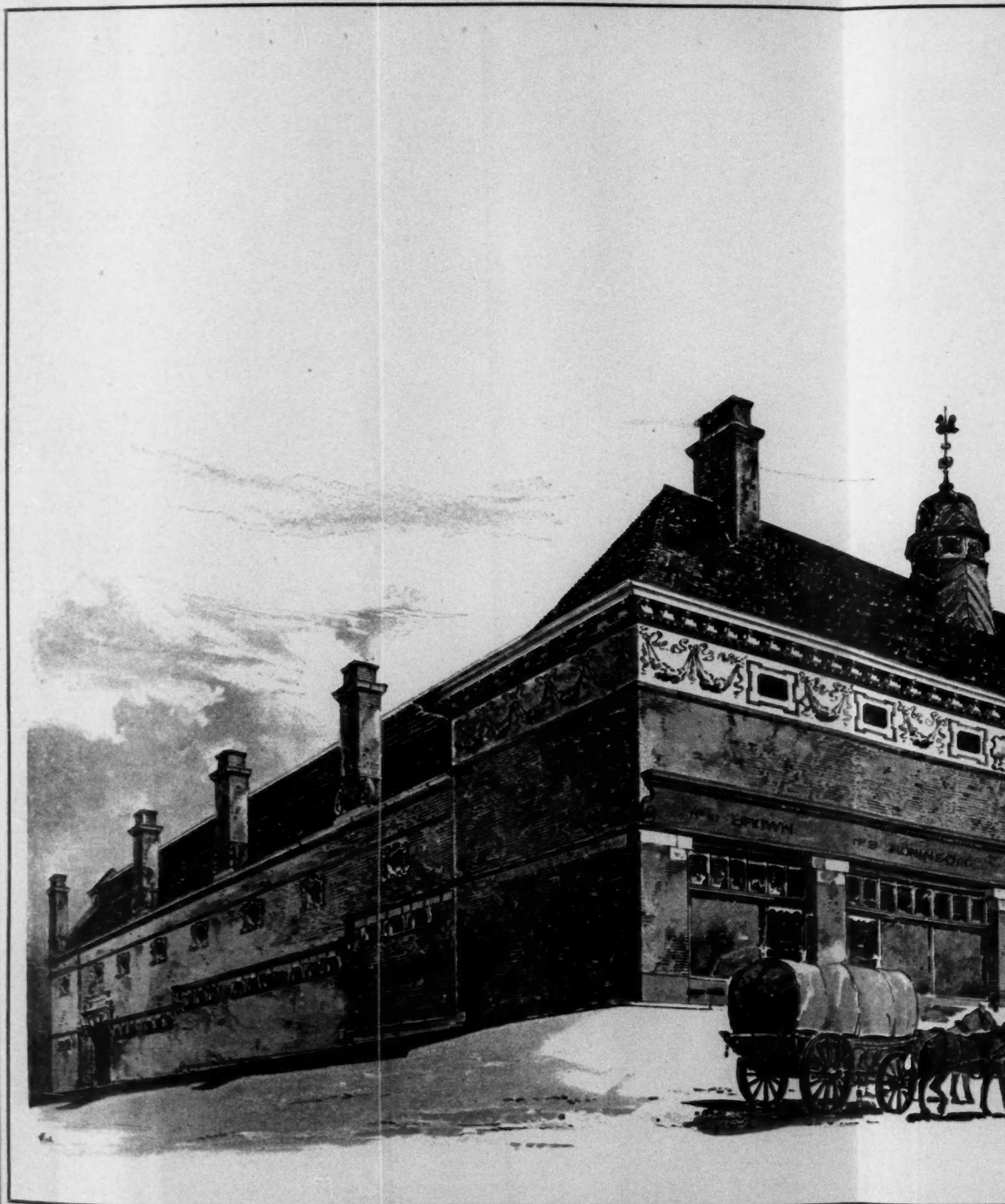


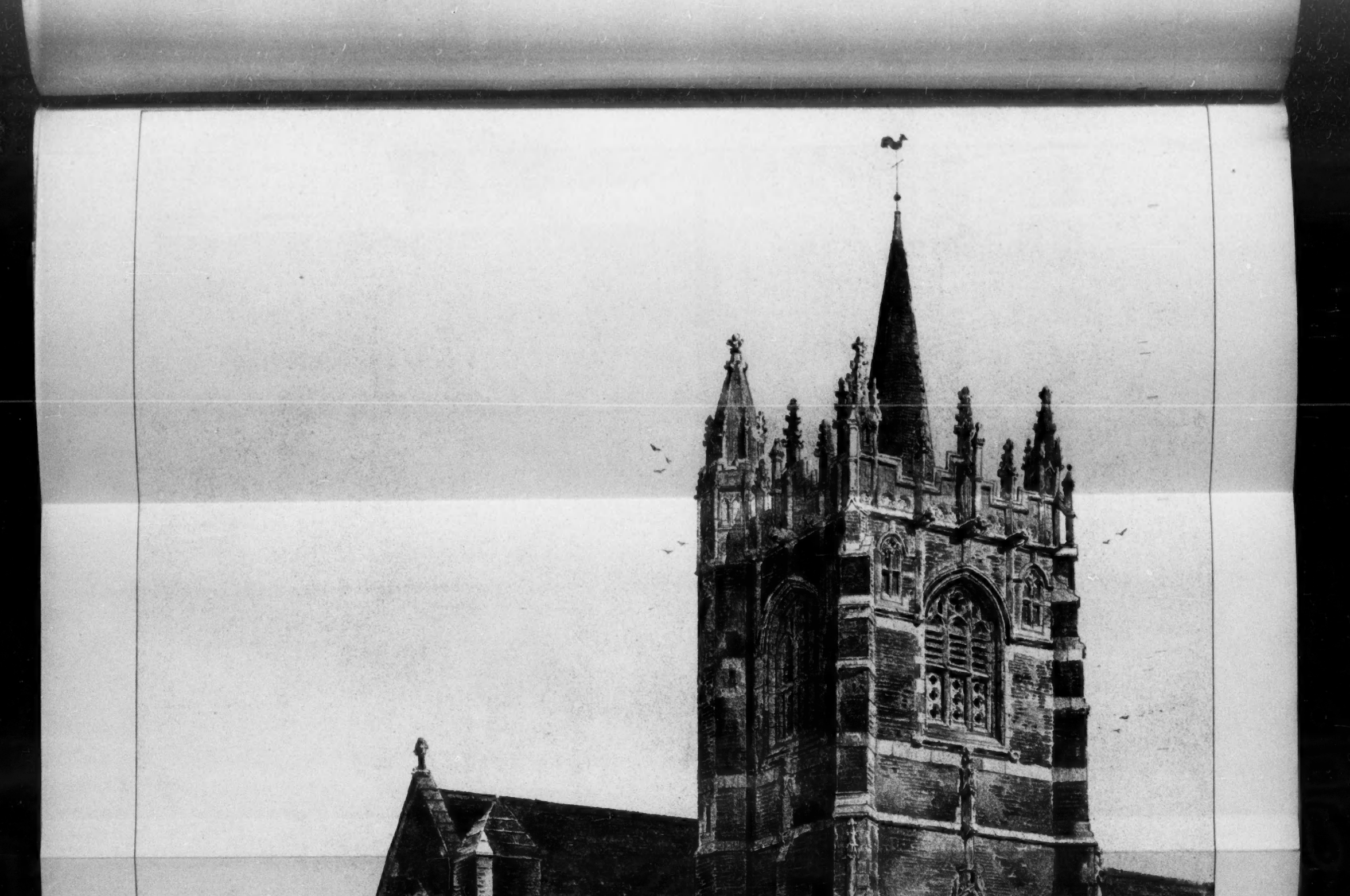
DESIGN FOR NEW MARKET HALL

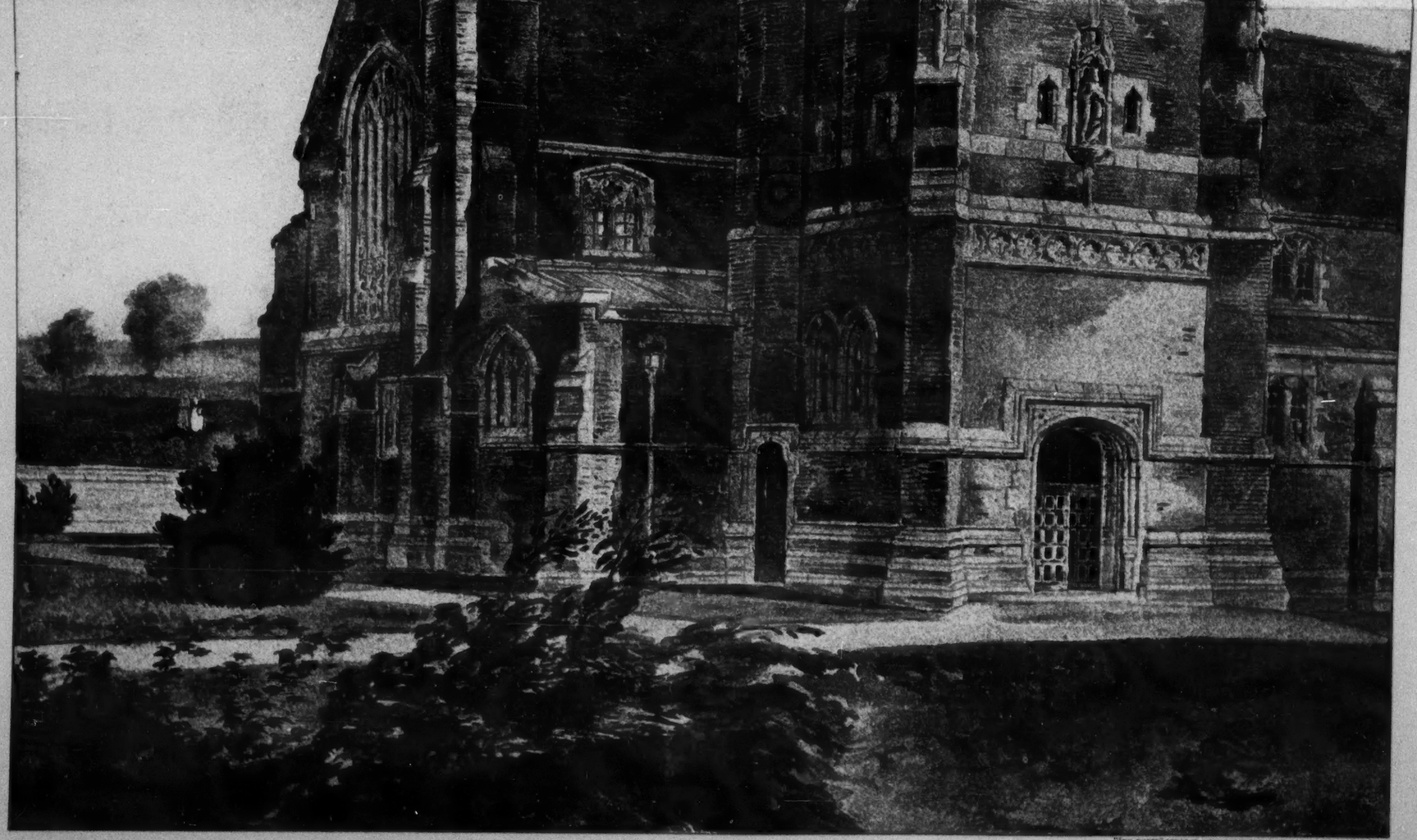
MITCHELL & BUTLER, ARCHITE

The Phototype Co., 293, Strand, London.

HALL, ROTHERHAM.

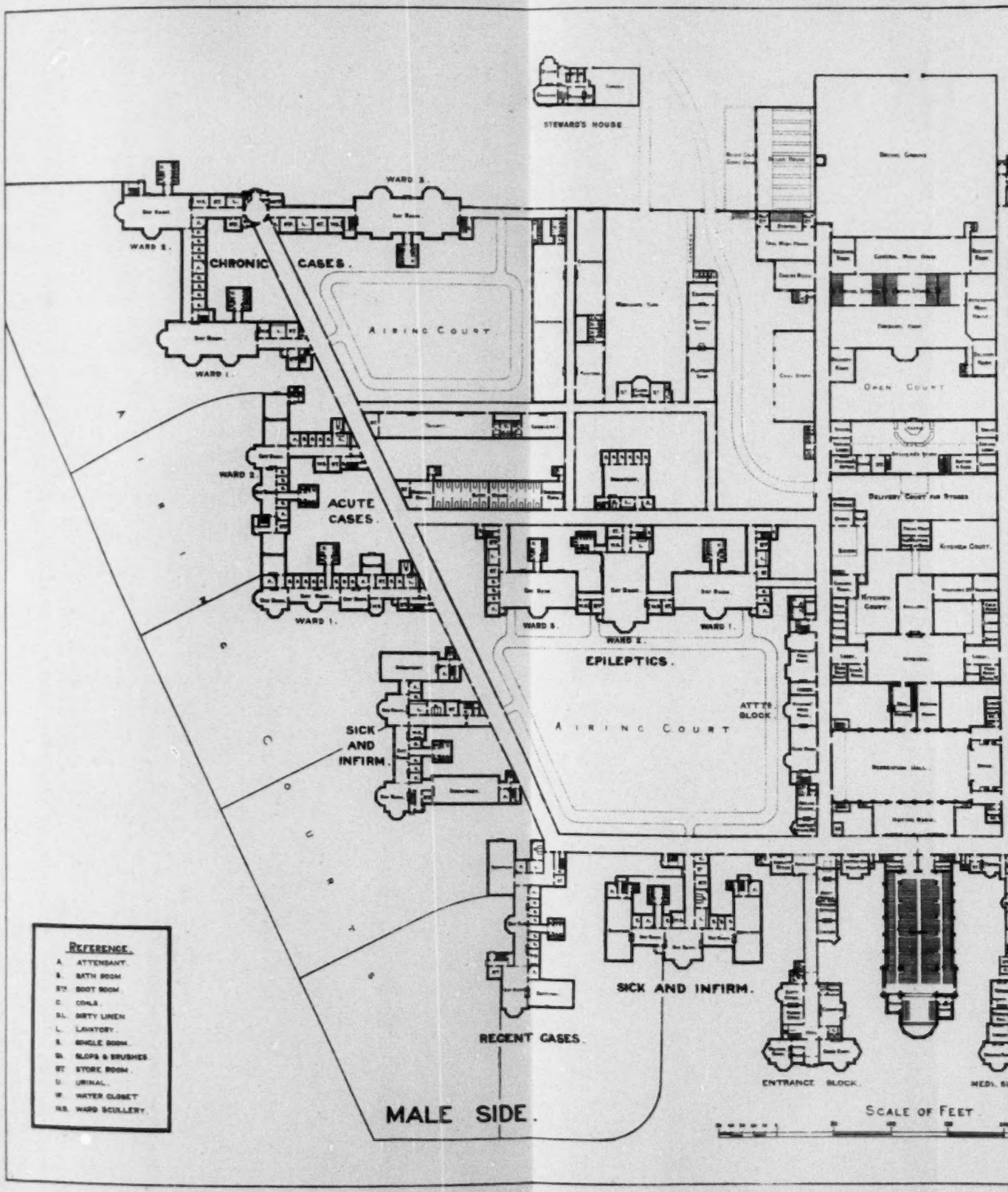
ARCHITECTS.





ST. JOHN'S CHURCH, STANSTEAD-MONT-FITCHET: TOWER AND WEST END.—Mr. W. D. Caröe, Architect.

PHOTO-LITHO. SPRAGUE & CO. 20, HARTING LANE, CARMON ST. LONDON, E.C.



MIDDLESEX FOURTH ASYLUM, CLAYBURY, ESS

GROUND PLAN.

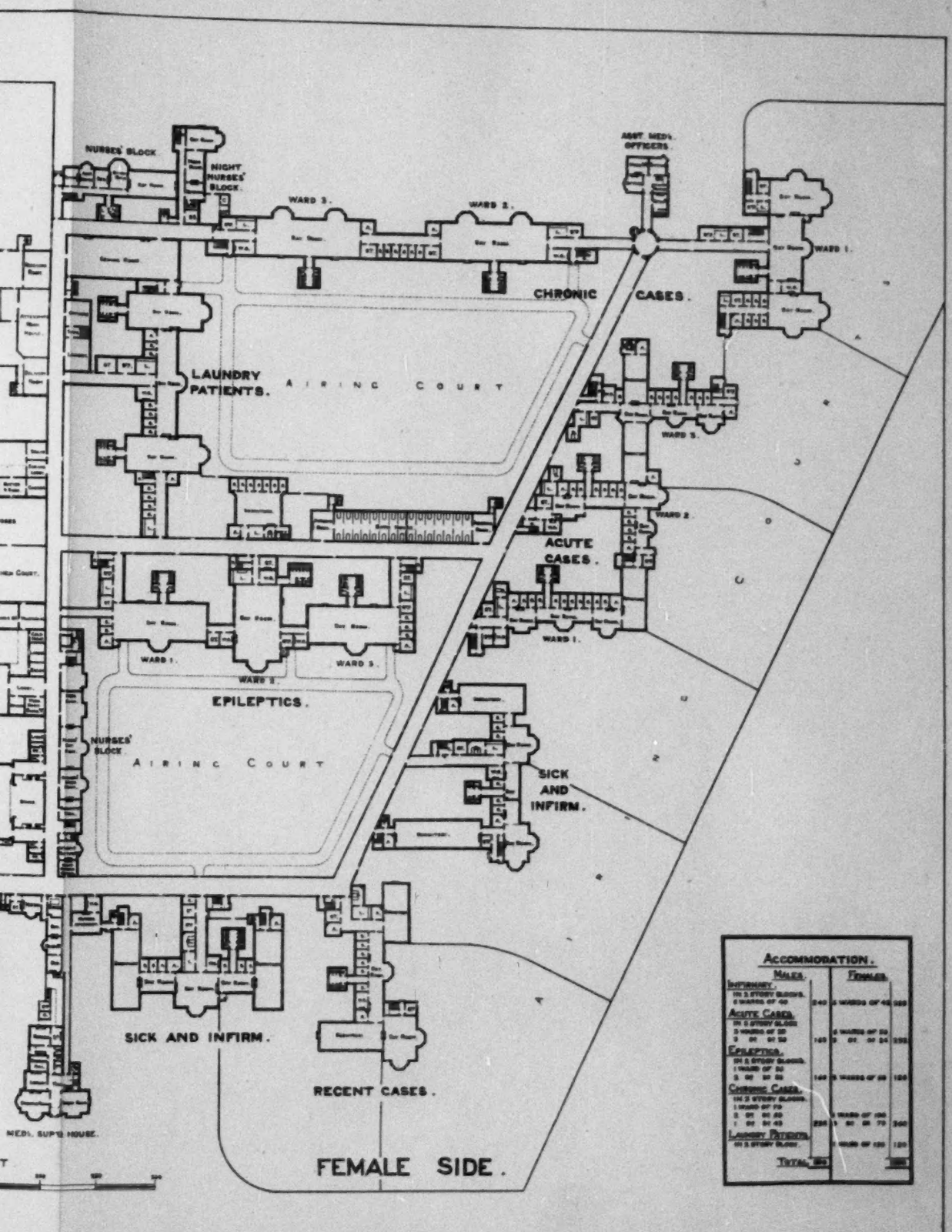


PHOTO-LITHO. SPRAGUE & CO. 62, MARTINS LANE CANNON ST. LONDON, E.C.

. ESSEX.—Mr. G. T. Hine, Architect.

AN.

entrance lodges and gateways and boundary fencing has cost about 50,000*l.* more.

The foundations were commenced last year by Messrs. Howell & Son, who, unfortunately, failed before they had done a third of their work, and have since been completed by Mr. H. Lovatt, of Wolverhampton. The lodges were built by Messrs. Higgs & Hill. The works are being carried out under the direction of the architect, Mr. George T. Hine, for the Asylums Committee of the London County Council, Mr. George Wise acting as principal clerk of works.

THE PARIS EXHIBITION BUILDINGS:

THE ARCHITECTURAL ASSOCIATION.

THE third meeting of this Association for the present session was held on the 15th inst., in the meeting-room of the Royal Institute of British Architects, Conduit-street, Mr. Leonard Stokes (President) in the chair. The following gentlemen were elected members, viz., Messrs. R. S. Lorimer, T. M. Smith, H. D. Blowers, E. Penfold, J. A. Brand, J. Lockhead, T. McGill Cassels, W. Bone, J. A. Barclay, J. Begg, G. W. Wilson, G. Watson, C. A. Norton, and A. Stratton.

Mr. T. E. Pryce announced that the "Common Room" would be opened for the first time on Friday, the 29th inst., at 6 p.m. After that date the room will be open at 6 o'clock every evening on which the various classes meet for the convenience of members attending the classes, and to give them an opportunity of meeting and discussing any subject of class or other work that may interest them. On Thursday, Dec. 17, the first general "Common Room" meeting will be held, when Mr. Sidney Beale and Mr. Collard will open a discussion on "The Position and Prospects of Architectural Assistants." Other meetings of this nature will be held from time to time. The "Common Room" Committee will be glad to receive through Mr. Appleton any suggestions as to subjects for discussion.

Mr. A. W. Earle said he wished to make a personal explanation relative to the remarks made by the President, and by the President of the Institute, in connexion with his (Mr. Earle's) proposal for the provision of a central building for the use of architects. Unfortunately, the building which he proposed had been dubbed a "College of Architecture"; but what he wished to see established was not a "College of Architecture," but merely a central building for use by architects, where the means of study should be concentrated. Mr. Waterhouse's enumeration of the different places in London to which the student had to journey was in itself an argument for the proposal which he (Mr. Earle) had made.

Mr. Banister F. Fletcher then read a paper on "The Paris Exhibition," of which we print the greater part:—

Commencing with the Palais des Machines, by M. Dutert, architect, and M. Contamin engineer, we find that it is an important structure, probably the most important in the Exposition for the lessons it teaches us in the proper application of iron. It is the largest building ever roofed in a single span. After several preliminary designs by M. Dutert, who, it may be remarked, wished the roof to be elliptical in form, with hipped ends, the present form was designed, which practically takes somewhat the outline of a Tudor arch springing from the ground. The pointed arch form also made the calculation comparatively easy, because it defined exactly where the strains were to come through. The plan consists of one large nave, 1,380 ft. long, and of twenty great principals or trusses springing from the ground, and having a clear span of 375 ft., and a height to the ridge of 141 ft. 10 in. There is no tie-rod to the roof at all.

There are galleries along each side, which are continued round the end at a height of 57 ft. 6 in. from the ground, and staircases at each end of the building under the connecting dome, which give access to it. The foundations would be too lengthy a matter to go into here, but it may be interesting to state that each of the foundations to the trusses is able to resist a vertical load of 405 tons 13 cwt., and a horizontal thrust of 113 tons. I give a section of one of these foundations along with the other drawings and photographs of the building. The concrete foundations to the side galleries are connected by stonework arches. The foundations to the main trusses are built in Portland cement, those to the side galleries being in hydraulic lime from Beffes, two of lime to five of sand. The different methods adopted of raising the great trusses by the two engineering firms who constructed it are very interesting, and the three plates I exhibit show these methods, and also the proposed scheme of raising half of each complete truss at one time. The twenty principal trusses are of wrought iron, and are bound together by five deep purlins on each side of the central articulation, the highest on each side being placed near together and carrying the exterior examining platform.

The purlins are framed in the thickness of the trusses. I give a drawing showing how this is done, and have shown resting on them, to the number of three between each truss, the principal rafters, which carry the secondary purlins, supporting the secondary rafters which carry the glass roofing.

The side galleries are covered with a segmental roof to each bay. The articulations of the great trusses are also of interest. There are three, one at the crown of the arch and one at the springing of each half truss, which, being reduced as it were to a point, rest on a roller plate of cast iron, which is fitted into the cast-iron shoe, which itself is bolted through to the stone foundation by tie-rods.

The strains, therefore, are taken right through the centre of the cast-iron roller plate. It is very similar to that of the Palais des Beaux-Arts. The lower part of the trusses is considerably strengthened by the addition of plates, the part immediately above the roller plate being made in cast-iron. The articulation at the top claims consideration. The ends of the two parallel girders forming the half-trusses are bound together by two half-cushions, which, in their turn, are clasped by a circular band of hammered iron, preventing any tendency to spread on the part of the trusses. These rest against a hollow steel pivot, which is the only point of connexion between the two trusses. Through this hollow steel pivot is passed a bolt which clasps, on each side of the truss, a steel ring which binds the whole together. To these rings, by means of ears, are fixed tie-rods in the two end bays, which run diagonally between the trusses from the ridge to the gutter. The weight of each truss is 196 tons, and the thrust on each articulation at the base 115 tons (which includes the weight of the covering as also the pressure of wind and snow).

The point of support of each roller plate at the base of the truss is about 7½ square feet, therefore the total weight of ironwork (7,400 tons) rests on a cast-iron surface of only 300 square feet, or nearly twenty-five tons to a square foot.

The fact of the trusses being 12 ft. 2 in. wide at the base and 9 ft. 10 in. at the summit, necessitated, of course, by the construction, has a great deal to do with the light and graceful effect of the roof as a whole.

The trusses are composed of two parallel girders, with top and bottom webs, 17¾ in. × ·35 in., joined by angle irons, and each having a top and bottom flange, the exterior flange being 30 in. wide and the interior 35 in. These flanges are thickened in various parts where required; for instance, at the base it has eight thicknesses. The upper and lower portions of the truss are joined by open lattice-work, the uprights being in double T-iron and the cross-bracing in T-iron. The method of distributing this lattice-work is well deserving of notice. In the space between the two girders forming the truss is a cleverly-contrived walking way from top to bottom by the aid of an internal ladder shown on the drawing, so that all ordinary repairs can be got at without the use of any scaffolding.

The method of forming the floors to the galleries, and the ceilings to those parts of the roof not covered with glass, and which are decorated with frescoes in colour, I illustrate by a few sketches.

The roofing is particularly noteworthy on account of its enormous size: it contains 631,857 square feet. The upper part is covered with glass ¼ in. thick, in slabs 6 ft. 6 in. × 1 ft. 8 in., which were severely tested; and it is painted white inside with a special solution, which it is said does not turn yellow. The vertical glazing to the Avenue de Suffren gable is composed of stained glass, representing the Battle of Bovines. The zinc work in the main roof is laid with rolls, and that to the side aisles (about 166,000 square feet) in zinc squares.

The gutters, and the method of forming flashings by the meeting of two iron surfaces, invented by M. Dutert, are interesting. An intermediate gutter had to be formed on the roof where the glass leaves off, this collecting gutter being necessary to break the force of the enormous sheet of descending water. This gutter empties itself into others, resting on the backs of the main principals. These gutters in their turn empty themselves into the main gutter, from which the water is led by down-pipes across the intermediate gutters of the side aisle roof and then by down-pipes to the ground. The gutters to these side roofs are made double in the event of an overflow.

To the exterior, the filling-in between the iron trusses at the bottom is in glazed bricks in patterns.

The Galerie des Machines was awarded the prize of 100,000 francs by the Press Committee, as being the most useful work in the Exposition, but one is inclined to think that it also combines beauty with utility to a marked degree. It is, in fact, the most distinctly original building in the Exposition, and as an engineering work I should say it would be considered superior to the Eiffel Tower. The St. Pancras roof, by Sir Gilbert Scott, is 240 ft. span, so that this roof is more than half as big again. It is, however, in all its details, a distinctly architectural work. It is a great thing too, that an original building of this sort should have been conceived by an architect, which is not generally the case. In the interior it will be seen that M. Dutert has attempted to take iron in ordinary sections, and by using the material in a common-sense way, to produce a building which shall be characteristic of the material in which it is built, as a building in any material should be, whether in iron, stone, brick, terra-cotta, or marble; and this is what men generally forget in designing iron structures, by endeavouring to imitate stone forms in iron.

For instance, the caps to the columns supporting the gallery are constructed entirely on a novel principle. There is no attempted imitation of the Grecian Doric, nor is there an architrave, frieze, and cornice, carefully worked out in iron, but a simple iron column, treated as such by the employment of ordinary iron sections rivetted together to form a decorative and characteristic whole. A building of this sort does more to advance a science and create an art than any amount of lecturing, and the architectural world has been waiting—well, probably, ever since iron was first employed, for an appreciative application of the material to building necessities; it has been scouted by our so-called art men, and its application in an artistic point of view spoiled by our engineers, whose bridges, viaducts, and railway stations contain no artistic feeling in their conception. The effect of this building on modern iron construction, no doubt, will be enormous. Iron may be said to be the only modern building material we have, all other building materials, in some form or other, have been used for centuries. Is it too much, then, to suppose that any new style of architecture will be based to a large extent on this material, all other styles having had their origin to a certain extent in the materials from time to time at hand? We have had half-timber houses (real ones I mean) in the Middle Ages; who knows, but that in the course of a decade or so, our town architecture will consist of half-iron buildings in which the interstices between the iron framing will be filled in with slabs of terra-cotta, instead of timber-framing and rough cast filling. This will enable us to have our hollow walls, the terra-cotta being placed on each side of a hollow space, as in the Argentine Pavilion, for example; and will also remove the old discussion of the best side to have the 4½ in. and 9 in. thickness.

In this Exposition we meet, perhaps for the first time, the architect and engineer working together, shoulder to shoulder, in the production of these great works; whether this be a foreshadowing of the amalgamation of the two professions, bringing us back to the state when they, undoubtedly, were one; or whether, on the other hand, it will lead to a more practical and genial relationship between the two, is not for me to say. It is, however, a step in the right direction, for whereas in English engineering works the architect is, if at all, called in at the last moment to beautify hideousness, the French, with the artistic instinct of their race, prefer that the architect should conceive and the engineer construct.

The "Palais des Expositions Diverses," the architect to which is M. Bouvard, I propose to dismiss in a few words. It is composed of ridge

and furrow roofing, in extremely light sections, with no tie rods. The main building is 1,344 ft. long by 626 ft. wide, and is bisected by the profusely-decorated "Galèrie de Trente Mètres," which joins the great dome and entrance to the low connecting dome leading into the Palais des Machines.

The roof of the "Galèrie de Trente Mètres" rests on wrought-iron standards, and is of Tudor form with lattice-framing. It has a span of 98 ft., and is divided into seven bays with an internal height of 80 ft. It is lighted from the top of the sides, the roof rafters showing, and being treated in different colours. The particular form of this roof was necessitated because it had to follow the outline of the great arch of the central dome. The arch of the roof is formed in lattice-work, there being no tie-rod. The bays which form the entrances to the French industries on either side of the gallery are, in themselves, the most important of the interior decorations in the whole Exhibition. I show a series of photographs of all these entrances as they were arranged side by side, but these, although they give the form, do not give the beautiful colouring. Each section choosing its own architect, the variety of thought and design crowded into this gallery is wonderful. All had practically the same frontage upon which to work, but the treatment of each entrance is distinct. The entrances are one and all endeavours to symbolise the products of the different sections exhibiting, or at least to give a design whose characteristic *motif* should convey an idea of the class represented. In fact, designs for entrances to an exhibition of the different trades in England would be a fascinating set of subjects for the class of colour decoration. I cannot do more here than refer to the photographs, and would specially call your attention to the entrances to "Meubles," to "Horlogerie," and to the Metallurgical section. These are three different types. That to "Meubles" is monochromatic, in plaster, and stained a dark-coloured mahogany. The general disposition will be seen by the photograph; the bas-reliefs and the figures representing a wood-carver, a cabinetmaker, &c., embellished with the names of celebrated French furniture designers, &c., go to make up a very characteristic whole.

The entrance to "Horlogerie" is a polychromatic design founded on the "Vieille Horloge" at Rouen, in which the different symbols of clockmaking, &c., are cleverly introduced. The Metallurgical section is comprised entirely of forged iron made at the works at Pompey, and is very cleverly put together, the arches being formed of lattice bracing and different *motifs* of tool making, such as hammers, wrenches, and various implements. These arches rest on circular columns, composed of open work of upright iron, held in position by bright iron bands. It is very ingeniously devised, being made entirely of ordinary sections, or sections made with ordinary machinery. All these compositions are worth study.

The Great Dome, by M. Bouvard, architect, is the marvel of decoration at the Exposition. I am fortunate in being able to show you a drawing which M. Bouvard very kindly gave me, which is an autographic reproduction of the original contract drawing, showing the construction.*

The entrance comprises a nave flanked right and left with two pavilions. The dome itself is formed by eight half trusses, supported by eight standards, 130 feet high. The diameter of the dome is 98 ft. 6 in.; the crown 196 feet from the ground. At the first floor is formed a circular iron balcony with a gracefully-designed balustrading, from which a magnificent view is obtained down the Champs de Mars between the legs of the great Eiffel Tower, and also a view down the Galerie de Trente Mètres of the various entrances to the different French courts, full of colour and variety of outline. Extending to the connecting dome of the Palais des Machines at the level of the first belt of ironwork, *i.e.*, 72 feet from the ground, the main coupled standards are brought together as it were by pediments in "staff" with sculptured *motifs* representing Air, Water, Steam, and Electricity, supported by pilasters. Between this first belt and the upper cornice is a deep decorative frieze 20 feet high, representing France inviting the nations of the world, and forming one of the most prominent features of the dome. It is painted in twelve panels, and you will see the stalwart Scotchman with bagpipes complete, who, curiously enough, represents England. Above, at the height of the third belt, are allegorical sculptures of Europe, Asia, Africa, and America. The trusses are again bound together by the crowning cornice with a blocking course, containing the shields and coats-of-arms of all the Powers represented at the Exposition. The lighting is effected by twelve large windows in the dome, between the pairs of principal trusses. The French flag forms the centre of the ornamentation at the top of the dome, from which escape, as it were, golden rays upon a deep blue sky studded with silver stars. For the exterior the constructive lines of the great iron trusses are accentuated in tones of Florentine bronze, picked out with lines of gold carried up to the summit, on which is placed a statue 30 ft. high, executed in zinc *répoussé* on a skeleton of cast steel. The total weight of this enormous statue is 7 tons 17 cwt.; and the framework has been calculated to withstand a pressure of wind equal to 154 lb. to $1\frac{1}{10}$ square yards. The materials employed in the construction of the dome are, firstly, the eight great iron principals; and, secondly, the eight half principals which spring from the Tudor arches connecting the main principals; and zinc, glazed terra-cotta, concrete in various colours, and "staff," or canvas plaster, are other materials used.

The ridge to the exterior of the dome, above the glazing, is formed with lions' heads in zinc *estampé*. The four griffins at the springing of the dome are in "staff," and fixed by wooden braces and angle irons. The drum of the dome below the glazing is in brick *apparente*, and ornamented with terra-cotta *cabochons*. The *motifs* in canvas plaster, which have been employed in the interior at the base, are secured to the ironwork forming the great arches by metal straps or iron network bedded in plaster. The decorative canvases in the interior are lined and fixed by the aid of glue. The general effect is pleasing, and the outline of the dome very fine, but the lines of the entrance and pediment are not happy, and the details of this part are anything but refined, the enormous statue, 30 ft. high at the top, completely destroying the scale.

It is necessary to emphasise very strongly the part which colour plays in the decoration of the dome; without it, it would lose much, if not most, of that grandeur and richness of effect it now possesses. The general effect of colouring produced in the interior, when lighted up by the electric light or with a strong western sun shining through the rich golden glass, leaves an impression never to be forgotten. The 15 mètre gallery and the four pavilions along its axis are good specimens of light iron construction, which time will not allow me to deal with, and our glance at the Galerie Rapp, which is symmetrical with the Galerie Desaix, and binds the Beaux-Arts Palace with the Palais des Expositions Diverses, must be very short. It has a span of 98 ft. 6 in., and rests at a distance of 32 ft. each side of the centre of the building on a row of cast-iron columns, which also carry the gallery running round the building. The ironwork is painted grey-blue.

The Galerie Rapp forms a vestibule, as it were, to the Palais des Beaux-Arts, as does the Galerie Desaix to the Palais des Arts Libéraux; these two palaces are similar in construction, with one or two exceptions. I am indebted to M. Formigé, the architect, and M. Contamin, the engineer, for the various blue prints and autographic plates which I am able to show you. This palais, as far as the exterior is concerned, is an example of the application of iron and terra-cotta, in which the ironwork is everywhere visible, the terra-cotta not being constructive. M. Formigé explained to me that in the 1878 Exhibition the ironwork was practically hidden, but in this design he desired to emphasise the construction as much as possible. The plan consists of a great nave, 738 ft. by 175 ft. 6 in. wide in one span, with side galleries the whole length. I have no time here to go through the interesting method of scaffolding adopted, nor to enter much into any detail of construction; but beside the large detail, I give a plate showing the general arrangement of the trusses, which are spaced 59 ft. 6 in. apart from centre to centre, and have a clear height of 92 ft. 6 in., the roof principals being really, though not apparently, taken right to the ground. The vertical portion of the truss, which is 4 ft. 6 in. by 2 ft. 6 in. on plan, consists of double girders, each having its flanges, webs, angle irons and lattice bracing, is 49 ft. 2 in. high; above this starts the curve of the intrados, which is formed by portions of two ellipses, the minor axis of which do not coincide with the axis or central line of the roof itself, thus making it slightly pointed. The back of the principal is struck with a radius of 300 ft. There are six lattice-work purlins on each side of the central articulation, and these are connected by intermediate rafters, to which are rivetted the cruciform sash bars. Both palaces are lighted from the roof. The articulations mentioned above are interesting and novel. Looking at the bottom articulation, we find that the foundation-plate is hollow on its upper surface, and is bolted to the stone piers. Into this slides the top portion of the bed plate, which, in its turn, receives the circular steel pin upon which the foot of the principal rests. The hollow foundation-plate was filled in with sand, by withdrawing or adding to which the absolute levels of the principals were preserved. The three drawings, I think, demonstrate this thoroughly. It will be seen in this case that there is a tie-rod 3 in. in diameter secured to the bed-plate, and passing under the ground to the opposite column. It is in three lengths. The articulation at the top is also interesting, and is very similar to that of the Palais des Machines. It will be seen that the two upper parts of the trusses are not connected in any way, but simply rest against the steel cylinder, which is 2 ft. 4½ in. long, and about 10 in. diameter—the ends of each truss being considerably strengthened by plate-iron and cast-iron plates, and bolts at the summit. The domes to these palaces are 100 ft. in diameter, and 196 ft. 10 in. from the ground.

M. Formigé has kindly given me a blue print showing the construction, from which it will be seen that the dome rests on four standards, from which spring the Tudor arches in light iron lattice work, supporting the dome itself. The tiles forming the covering to the dome had to be made of a special design because there is no overlapping, the tiles presenting a level face. Several attempts were tried to get these really watertight; but even now, M. Formigé told me, they were not so, and the dome had to be covered underneath these tiles with zinc. The Beaux-Arts dome differs from that to the Palais des Arts Libéraux to this extent, that it has a wide gallery at the first-floor level, approached from staircases at the four corners of the dome. These staircases are most satisfactory in their outline and general proportions, the stonework arches supporting them following the rake of the staircase, the centre arch being a low elliptical one. The iron balustrading is extremely rich and elegant in design. Externally, the roof principals to the side aisles rest on hollow iron lattice-work standards 3 ft. 7 in. square, filled in with light Venetian red terra-cotta slabs (about 1 in. thick). These slabs are fluted, but the ornamentation on them is somewhat hurried.

The sides of these standards are filled in with cross-bracing, which, however, breaks rather awkwardly through the designs on the terra-cotta panels. In front there is only horizontal bracing dividing the panels. The standards rest on a stone base, are 25 ft. apart, and have on each side a circular cast-iron column helping to carry the connecting lattice-work girder, which also carries a close terra-cotta balustrading; above this are the windows stretching from pier to pier, with double lattice arch above, rivetted to the standards, and carrying the architrave, terra-cotta frieze, and cornice, and above this the heavy terra-cotta balustrading.

The main entrances are in terra-cotta, and differ slightly in general composition. They can be seen from the photographs.* The façades to these two palaces are very suggestive in their composition, the grey-blue of the ironwork harmonising with the soft Venetian red of the terra-cotta. A modern street front based on this idea would be very suitable, a maximum amount of light being obtained, and the bold projection of the piers giving a deep shadow, and the harmony of the grey-blue and Venetian red being very pleasing. An ingenious architect might even turn the hollow standards into lifts, thus wasting no space at all. The appearance of the tiled domes in turquoise blue, yellow, and cream colour in patterns, with the letters "R. F." in the centre, is very satisfactory, the constructive lines being marked by broad bands of yellow tiling. The circular windows at the

* A reduced reproduction of this drawing was given in the *Builder* for January 31, 1888 (p. 44).

* An illustration of the entrance to the Palais des Arts Libéraux will be found in the *Builder* for October 26 of this year, with enlarged illustrations of the sculptural decoration on the piers.

base of the dome are formed in glazed blue and white voussoirs, with consoles between supporting vases. Though lacking the boldness of M. Bouvard's dome, these domes are probably more graceful in detail and outline.

I have now given you roughly an idea of the great buildings at the Exposition, and I propose now to deal with the two most original foreign pavilions in the Exposition. And, firstly, the Argentine Pavilion, by M. Albert Ballu, architect, the son of that Ballu who, with Deperthes, erected the modern Hotel de Ville in Paris, is the most original in the whole Exposition, and I am fortunate in being able to place before you this evening a complete set of working drawings of the building, comprising fifteen double elephant sheets, kindly given me by M. Ballu. Briefly, the building consists of a central dome, with four smaller domes grouped around, and on each side of this central feature extends a wing with central naves and aisles. This is in two floors. As time is short, I do not propose to enter into details, which the drawings will sufficiently explain.

M. Ballu told me that his idea in designing the building was to make use of all modern materials which could in any way be worked into the design. The pavilion has therefore been built up with a framework of iron, and the materials used for filling in are terra-cotta, faïence, glazed tiles, coloured glass as bull's-eyes, or *cabochons*, as they call them in France. The building itself is put together in its larger parts by the aid of bolts and screws, as it is the intention of the Argentine Republic to have it re-erected in Buenos Ayres. The pendentives to the central dome are in bronze.

The large semi-circular openings to the centre of the *façade* are separated by piers formed by an iron framework, and filled in with buff terra-cotta, blue tiles, and glass prisms in different colours. These latter are hollow, and at their back is placed a thin layer of glass mosaic, to prevent a hollow appearance. The projecting iron balconies, elliptical on plan, are supported by light iron cantilevers painted gold, and are extremely graceful. The main cornice is supported by iron consoles running through the frieze, and between these columns is a prism of green glass. The ironwork internally is painted gold and green. The reveals to the arches to the main entrance are filled in with real mosaic, the dominant colours being blue, red, gold, and white.

The divisions of the main *façade* are surrounded by two deep rows of plain tiles. These divisions are sub-divided into three by light circular columns and caps in the Renaissance style, with semi-circular arches, all the ironwork being painted gold, with great richness of effect. The base of the building is composed of a mixture of burnt sienna coloured terra-cotta, with a row of blue glass prisms and a cornice of bright tiles with yellow cats painted on, and treated in a conventional way. The inside ironwork is latticed—a method of iron treatment evidently considered graceful by the French. This building, no doubt, had a great influence on the design of the surrounding buildings, and M. Ballu has, I believe, taken action before the "Comité de la Protection Artistique." The building cost 48,000*l*.

All the South American pavilions are instructive, showing something of a new method of building. In the Mexican Pavilion, for instance, the facing to the external walls is performed in stamped zinc. The Chili Pavilion, the architect to which is M. Picq, is built entirely of an iron framework, with terra-cotta panels in varied colours as a filling in. It is to be removed to Chili. The terra-cotta panels, I may mention, are placed at the edges of the upright framing in such a way as to practically form hollow walling. The ironwork internally is painted in blue-grey. It is utterly impossible even to mention the names of all the pavilions, and I must not attempt to do so; these are fully treated of in my report. I may, however, mention the work of an English architect, the only example, I believe, at the Exhibition. I refer to the Indian Pavilion, by Mr. Purdon Clarke, F.R.I.B.A., who has been kind enough to forward me some plates showing his design. It is executed with a framework of wood and covered with plaster. Parts of it are reproductions from Indian buildings.

For the buildings on the Champs de Mars I must refer you to the photographs, which are arranged in order, and which, I hope, will give you a very fair idea of the Exhibition. The habitations of man in all ages, by M. Charles Garnier, I have illustrated by a complete series of photographs. With the want of time, space, and money at M. Garnier's disposal, I think he ought to be congratulated on doing what he has done with so difficult a subject.

Before quitting the Quai d'Orsay, I should like to bring to your attention a little circular iron building, containing the Petroleum Exhibition. It is constructed of circular iron bands of sheet iron, 9 ft. long by 3 ft. 3 in., rivetted together with lead rivets in order to facilitate removing, but the most peculiar part of it is that it was built from the top to the bottom, the plates being held in position by strong cranes until the bottom plate was reached. This was done in order that the floods of the Seine during the spring should not wash the building away, there being practically no foundations.

I suppose one ought to say something of the Eiffel Tower, about which so much has been said and written. Mr. Hamerton's definition that "it is a land lighthouse prepared to resist the wind and not the waves," is probably as good a definition as can be found for it. As an engineering work there is nothing to be said against it, but it is inferior to the Forth Bridge, the total length of one of whose spans is twice the height of the Tower, and it also appears inferior to the Palais des Machines as a feat of engineering skill. It is no doubt, however, a wonderful structure in its way, and one cannot deny that the bold sweep of its four great legs, united at the base, and its circular arch, which, however, is not structural, is distinctly pleasing. Another great point is its extreme simplicity, only marred when the architect was called in to design the arcading to the two *étages*. Moreover, in looking at the tower we must remember that it is an extraordinary structure (using that word in its original sense), and that we cannot bring ordinary standards of beauty,—standards, we may say, which belong to stone or brick,—to bear upon a structure outside its range. For instance, the ordinary æsthetic principles we apply to a Greek temple or Gothic church, or a Queen Anne house, are totally inapplicable here, and we must not attempt to judge it by these rules. It was from trying to do this that the architectural, artistic, and literary world of France came such a "cropper," if you will allow me to say so. They had in their mind a solid-looking structure, towering with its black mass (like a factory chimney-shaft, as they said) 1,000 ft. in the air. They had never seen an Eiffel Tower, it being the first of its race (which we may hope will be a short-lived one), and they could not realise the graceful appearance of this lace-like monument, rising like a spider's web in the air, and crushing nothing, dwarfing nothing, by its graceful proportions; whereas a tower or lighthouse of stone or brick would do exactly what they said it would, it would crush and utterly destroy the architectural beauty of Paris.

There is no doubt that this open lace-work of the tower saves it from a failure, and I would strongly caution the powers that be to abstain from filling it with terra-cotta panels as has been suggested. This done the tower will indeed be a failure and an eyesore to Paris. The buildings on the Esplanade des Invalides are interesting, though not so much from a constructive point of view. The buildings, with some few exceptions, are devoted to the French colonies, to the Ministry of War, and to Sanitary Science, and are of a temporary nature. The colonial buildings are representative of the architecture indigenous to the various colonies, and are in this respect interesting, giving us real buildings, which in the majority of cases can only be seen by us on paper.

The Algerian Palace, Tunisian Palace, the Colonial Palace, the Annam and Tonkin Pavilion, and the Indo-China Pavilion are the principal buildings on the east side, and are constructed in *pan-de-bois*, or brick nogging.

On the west side is the Health Exhibition, the Ministry of War, the Post and Telegraph Pavilion. The construction of these latter is in some respects novel.

A very important material in use in the eastern building is clay, which, being burnt, and when in its plastic state has fragments of different coloured porcelains and marble embedded in it. This is then baked, and forms a very good constructional and decorative material. The Post and Telegraph Pavilion, by M. Boussard, is peculiar as having a large central hall, 49 ft. by 59 ft., roofed by means of wooden lattice framing bolted together and without a tie-rod.

Architectural Drawings.

In my report I have gone rather fully into the differences between the English and French schools of drawing. I suppose that there never has been a finer or a more representative collection of architectural drawings brought together in one exhibition. One of the chief differences is the large extent to which the French go in for classical restorations in which colour is largely introduced, the winners of the Prix-de-Rome being sent out to Greece and Rome for this purpose. English students, on the contrary, either stop at home to sketch or measure in black and white, or go on a foreign tour with the same object. Colour is the exception in the architectural drawings by English students. One sees comparatively few fresh drawings of old French work in the exhibition, and even these are all executed with colour. Another great point is the size of the French designs, and the absence of perspective which one meets in French work. The scale usually employed is two centimètres to the mètre, or $\frac{1}{50}$, which is practically equal to over $\frac{1}{4}$ in. scale to the foot, and for details five centimètres to the mètre, or $\frac{1}{10}$ full size, half full size also being used, and in all these details the shadows are carefully shown. The importance of the plan in comparison with the elevation is emphasised. In England this is not so in exhibitions. This, no doubt, is the fault of the Architectural Room at the Royal Academy.

The system of shadows and the absence of perspective naturally go together; one is not so much wanted where the other is employed. But it is this respect of shadow throwing which accounts to a large extent for the other differences as to scale, composition, &c. We can easily see, for example, that shadows on a small drawing are almost useless, the masses are not big enough to be appreciated. With regard to detail drawing, M. Dutert, M. Sédille, and other well-known French architects admitted that they could not understand how the English architect could design them without the help of shadows. Another point is the more complete study of the figure by French architects. Both of these differences are of course brought about by the early training. The decorative competitions held at the École des Beaux-Arts, in which painters, architects, and sculptors enter, of course necessitate the architect having a complete knowledge of the human figure. Then, again, one notices the absence of new domestic work at the Exposition, and what is there is bad. French country houses are designed, if I may say so, on the "square and high" principle instead of in the "long and low," which is the proper way to design a country-house, at any rate of small size.

The English and Americans have thoroughly grasped this fact. There is no doubt that the French system of shadows, and absence of perspective, so necessary in this class of work, is partly accountable for this. From the study of the French system, then, one would say that it works admirably for public buildings with large *façades* (especially when aided, as it so frequently is in France, by plaster models of the buildings to a large scale), and also for the preparation of details, but that for the designing of country residences, the English and American perspective system is to be preferred.

Before closing, I have a pleasing duty to perform, viz., to thank those gentlemen, both English and foreign, who have been good enough by introductions or indications to help me in the somewhat large undertaking of reporting on this Exposition. Of the English architects I am indebted to Mr. Arthur Cates, the founder of this studentship, for his generosity in doing so, and for introductions to Mr. Cesar Daly, &c.

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and furrow roofing, in extremely light sections, with no tie rods. The main building is 1,344 ft. long by 626 ft. wide, and is bisected by the profusely-decorated "Galèrie de Trente Mètres," which joins the great dome and entrance to the low connecting dome leading into the Palais des Machines.

The roof of the "Galèrie de Trente Mètres" rests on wrought-iron standards, and is of Tudor form with lattice-framing. It has a span of 98 ft., and is divided into seven bays with an internal height of 80 ft. It is lighted from the top of the sides, the roof rafters showing, and being treated in different colours. The particular form of this roof was necessitated because it had to follow the outline of the great arch of the central dome. The arch of the roof is formed in lattice-work, there being no tie-rod. The bays which form the entrances to the French industries on either side of the gallery are, in themselves, the most important of the interior decorations in the whole Exhibition. I show a series of photographs of all these entrances as they were arranged side by side, but these, although they give the form, do not give the beautiful colouring. Each section choosing its own architect, the variety of thought and design crowded into this gallery is wonderful. All had practically the same frontage upon which to work, but the treatment of each entrance is distinct. The entrances are one and all endeavours to symbolise the products of the different sections exhibiting, or at least to give a design whose characteristic *motif* should convey an idea of the class represented. In fact, designs for entrances to an exhibition of the different trades in England would be a fascinating set of subjects for the class of colour decoration. I cannot do more here than refer to the photographs, and would specially call your attention to the entrances to "Meubles," to "Horlogerie," and to the Metallurgical section. These are three different types. That to "Meubles" is monochromatic, in plaster, and stained a dark-coloured mahogany. The general disposition will be seen by the photograph; the bas-reliefs and the figures representing a wood-carver, a cabinetmaker, &c., embellished with the names of celebrated French furniture designers, &c., go to make up a very characteristic whole.

The entrance to "Horlogerie" is a polychromatic design founded on the "Vieille Horloge" at Rouen, in which the different symbols of clockmaking, &c., are cleverly introduced. The Metallurgical section is comprised entirely of forged iron made at the works at Pompey, and is very cleverly put together, the arches being formed of lattice bracing and different *motifs* of tool making, such as hammers, wrenches, and various implements. These arches rest on circular columns, composed of open work of upright iron, held in position by bright iron bands. It is very ingeniously devised, being made entirely of ordinary sections, or sections made with ordinary machinery. All these compositions are worth study.

The Great Dome, by M. Bouvard, architect, is the marvel of decoration at the Exposition. I am fortunate in being able to show you a drawing which M. Bouvard very kindly gave me, which is an autographic reproduction of the original contract drawing, showing the construction.*

The entrance comprises a nave flanked right and left with two pavilions. The dome itself is formed by eight half trusses, supported by eight standards, 130 feet high. The diameter of the dome is 98 ft. 6 in.; the crown 196 feet from the ground. At the first floor is formed a circular iron balcony with a gracefully-designed balustrading, from which a magnificent view is obtained down the Champs de Mars between the legs of the great Eiffel Tower, and also a view down the Galerie de Trente Mètres of the various entrances to the different French courts, full of colour and variety of outline. Extending to the connecting dome of the Palais des Machines at the level of the first belt of iron-work, *i.e.*, 72 feet from the ground, the main coupled standards are brought together as it were by pediments in "staff" with sculptured *motifs* representing Air, Water, Steam, and Electricity, supported by pilasters. Between this first belt and the upper cornice is a deep decorative frieze 20 feet high, representing France inviting the nations of the world, and forming one of the most prominent features of the dome. It is painted in twelve panels, and you will see the stalwart Scotchman with bagpipes complete, who, curiously enough, represents England. Above, at the height of the third belt, are allegorical sculptures of Europe, Asia, Africa, and America. The trusses are again bound together by the crowning cornice with a blocking course, containing the shields and coats-of-arms of all the Powers represented at the Exposition. The lighting is effected by twelve large windows in the dome, between the pairs of principal trusses. The French flag forms the centre of the ornamentation at the top of the dome, from which escape, as it were, golden rays upon a deep blue sky studded with silver stars. For the exterior the constructive lines of the great iron trusses are accentuated in tones of Florentine bronze, picked out with lines of gold carried up to the summit, on which is placed a statue 30 ft. high, executed in zinc *répoussé* on a skeleton of cast steel. The total weight of this enormous statue is 7 tons 17 cwt.; and the framework has been calculated to withstand a pressure of wind equal to 154 lb. to $1\frac{1}{10}$ square yards. The materials employed in the construction of the dome are, firstly, the eight great iron principals; and, secondly, the eight half principals which spring from the Tudor arches connecting the main principals; and zinc, glazed terra-cotta, concrete in various colours, and "staff," or canvas plaster, are other materials used.

The ridge to the exterior of the dome, above the glazing, is formed with lions' heads in zinc *estampé*. The four griffins at the springing of the dome are in "staff," and fixed by wooden braces and angle irons. The drum of the dome below the glazing is in brick *apparente*, and ornamented with terra-cotta *cabochons*. The *motifs* in canvas plaster, which have been employed in the interior at the base, are secured to the ironwork forming the great arches by metal straps or iron network bedded in plaster. The decorative canvases in the interior are lined and fixed by the aid of glue. The general effect is pleasing, and the outline of the dome very fine, but the lines of the entrance and pediment are not happy, and the details of this part are anything but refined, the enormous statue, 30 ft. high at the top, completely destroying the scale.

It is necessary to emphasise very strongly the part which colour plays in the decoration of the dome; without it, it would lose much, if not most, of that grandeur and richness of effect it now possesses. The general effect of colouring produced in the interior, when lighted up by the electric light or with a strong western sun shining through the rich golden glass, leaves an impression never to be forgotten. The 15 mètre gallery and the four pavilions along its axis are good specimens of light iron construction, which time will not allow me to deal with, and our glance at the Galerie Rapp, which is symmetrical with the Galerie Desaix, and binds the Beaux-Arts Palace with the Palais des Expositions Diverses, must be very short. It has a span of 98 ft. 6 in., and rests at a distance of 32 ft. each side of the centre of the building on a row of cast-iron columns, which also carry the gallery running round the building. The ironwork is painted grey-blue.

The Galerie Rapp forms a vestibule, as it were, to the Palais des Beaux-Arts, as does the Galerie Desaix to the Palais des Arts Libéraux; these two palaces are similar in construction, with one or two exceptions. I am indebted to M. Formigé, the architect, and M. Contamin, the engineer, for the various blue prints and autographic plates which I am able to show you. This palais, as far as the exterior is concerned, is an example of the application of iron and terra-cotta, in which the ironwork is everywhere visible, the terra-cotta not being constructive. M. Formigé explained to me that in the 1878 Exhibition the ironwork was practically hidden, but in this design he desired to emphasise the construction as much as possible. The plan consists of a great nave, 738 ft. by 175 ft. 6 in. wide in one span, with side galleries the whole length. I have no time here to go through the interesting method of scaffolding adopted, nor to enter much into any detail of construction; but beside the large detail, I give a plate showing the general arrangement of the trusses, which are spaced 59 ft. 6 in. apart from centre to centre, and have a clear height of 92 ft. 6 in., the roof principals being really, though not apparently, taken right to the ground. The vertical portion of the truss, which is 4 ft. 6 in. by 2 ft. 6 in. on plan, consists of double girders, each having its flanges, webs, angle irons and lattice bracing, is 49 ft. 2 in. high; above this starts the curve of the intrados, which is formed by portions of two ellipses, the minor axis of which do not coincide with the axis or central line of the roof itself, thus making it slightly pointed. The back of the principal is struck with a radius of 300 ft. There are six lattice-work purlins on each side of the central articulation, and these are connected by intermediate rafters, to which are rivetted the cruciform sash bars. Both palaces are lighted from the roof. The articulations mentioned above are interesting and novel. Looking at the bottom articulation, we find that the foundation-plate is hollow on its upper surface, and is bolted to the stone piers. Into this slides the top portion of the bed plate, which, in its turn, receives the circular steel pin upon which the foot of the principal rests. The hollow foundation-plate was filled in with sand, by withdrawing or adding to which the absolute levels of the principals were preserved. The three drawings, I think, demonstrate this thoroughly. It will be seen in this case that there is a tie-rod 3 in. in diameter secured to the bed-plate, and passing under the ground to the opposite column. It is in three lengths. The articulation at the top is also interesting, and is very similar to that of the Palais des Machines. It will be seen that the two upper parts of the trusses are not connected in any way, but simply rest against the steel cylinder, which is 2 ft. 4½ in. long, and about 10 in. diameter—the ends of each truss being considerably strengthened by plate-iron and cast-iron plates, and bolts at the summit. The domes to these palaces are 100 ft. in diameter, and 196 ft. 10 in. from the ground.

M. Formigé has kindly given me a blue print showing the construction, from which it will be seen that the dome rests on four standards, from which spring the Tudor arches in light iron lattice work, supporting the dome itself. The tiles forming the covering to the dome had to be made of a special design because there is no overlapping, the tiles presenting a level face. Several attempts were tried to get these really watertight; but even now, M. Formigé told me, they were not so, and the dome had to be covered underneath these tiles with zinc. The Beaux-Arts dome differs from that to the Palais des Arts Libéraux to this extent, that it has a wide gallery at the first-floor level, approached from staircases at the four corners of the dome. These staircases are most satisfactory in their outline and general proportions, the stonework arches supporting them following the rake of the staircase, the centre arch being a low elliptical one. The iron balustrading is extremely rich and elegant in design. Externally, the roof principals to the side aisles rest on hollow iron lattice-work standards 3 ft. 7 in. square, filled in with light Venetian red terra-cotta slabs (about 1 in. thick). These slabs are fluted, but the ornamentation on them is somewhat hurried.

The sides of these standards are filled in with cross-bracing, which, however, breaks rather awkwardly through the designs on the terra-cotta panels. In front there is only horizontal bracing dividing the panels. The standards rest on a stone base, are 25 ft. apart, and have on each side a circular cast-iron column helping to carry the connecting lattice-work girder, which also carries a close terra-cotta balustrading; above this are the windows stretching from pier to pier, with double lattice arch above, rivetted to the standards, and carrying the architrave, terra-cotta frieze, and cornice, and above this the heavy terra-cotta balustrading.

The main entrances are in terra-cotta, and differ slightly in general composition. They can be seen from the photographs.* The façades to these two palaces are very suggestive in their composition, the grey-blue of the ironwork harmonising with the soft Venetian red of the terra-cotta. A modern street front based on this idea would be very suitable, a maximum amount of light being obtained, and the bold projection of the piers giving a deep shadow, and the harmony of the grey-blue and Venetian red being very pleasing. An ingenious architect might even turn the hollow standards into lifts, thus wasting no space at all. The appearance of the tiled domes in turquoise blue, yellow, and cream colour in patterns, with the letters "R. F." in the centre, is very satisfactory, the constructive lines being marked by broad bands of yellow tiling. The circular windows at the

* A reduced reproduction of this drawing was given in the *Builder* for January 21, 1888 (p. 44).

* An illustration of the entrance to the Palais des Arts Libéraux will be found in the *Builder* for October 26 of this year, with enlarged illustrations of the sculptural decoration on the piers.

base of the dome are formed in glazed blue and white voussoirs, with consoles between supporting vases. Though lacking the boldness of M. Bouvard's dome, these domes are probably more graceful in detail and outline.

I have now given you roughly an idea of the great buildings at the Exposition, and I propose now to deal with the two most original foreign pavilions in the Exposition. And, firstly, the Argentine Pavilion, by M. Albert Ballu, architect, the son of that Ballu who, with Deperthes, erected the modern Hotel de Ville in Paris, is the most original in the whole Exposition, and I am fortunate in being able to place before you this evening a complete set of working drawings of the building, comprising fifteen double elephant sheets, kindly given me by M. Ballu. Briefly, the building consists of a central dome, with four smaller domes grouped around, and on each side of this central feature extends a wing with central naves and aisles. This is in two floors. As time is short, I do not propose to enter into details, which the drawings will sufficiently explain.

M. Ballu told me that his idea in designing the building was to make use of all modern materials which could in any way be worked into the design. The pavilion has therefore been built up with a framework of iron, and the materials used for filling in are terra-cotta, faïence, glazed tiles, coloured glass as bull's-eyes, or *cabochons*, as they call them in France. The building itself is put together in its larger parts by the aid of bolts and screws, as it is the intention of the Argentine Republic to have it re-erected in Buenos Ayres. The pendentives to the central dome are in bronze.

The large semi-circular openings to the centre of the *façade* are separated by piers formed by an iron framework, and filled in with buff terra-cotta, blue tiles, and glass prisms in different colours. These latter are hollow, and at their back is placed a thin layer of glass mosaic, to prevent a hollow appearance. The projecting iron balconies, elliptical on plan, are supported by light iron cantilevers painted gold, and are extremely graceful. The main cornice is supported by iron consoles running through the frieze, and between these columns is a prism of green glass. The ironwork internally is painted gold and green. The reveals to the arches to the main entrance are filled in with real mosaic, the dominant colours being blue, red, gold, and white.

The divisions of the main *façade* are surrounded by two deep rows of plain tiles. These divisions are sub-divided into three by light circular columns and caps in the Renaissance style, with semi-circular arches, all the ironwork being painted gold, with great richness of effect. The base of the building is composed of a mixture of burnt sienna coloured terra-cotta, with a row of blue glass prisms and a cornice of bright tiles with yellow cats painted on, and treated in a conventional way. The inside ironwork is latticed—a method of iron treatment evidently considered graceful by the French. This building, no doubt, had a great influence on the design of the surrounding buildings, and M. Ballu has, I believe, taken action before the "Comité de la Protection Artistique." The building cost 48,000*l*.

All the South American pavilions are instructive, showing something of a new method of building. In the Mexican Pavilion, for instance, the facing to the external walls is performed in stamped zinc. The Chili Pavilion, the architect to which is M. Picq, is built entirely of an iron framework, with terra-cotta panels in varied colours as a filling in. It is to be removed to Chili. The terra-cotta panels, I may mention, are placed at the edges of the upright framing in such a way as to practically form hollow walling. The ironwork internally is painted in blue-grey. It is utterly impossible even to mention the names of all the pavilions, and I must not attempt to do so; these are fully treated of in my report. I may, however, mention the work of an English architect, the only example, I believe, at the Exhibition. I refer to the Indian Pavilion, by Mr. Purdon Clarke, F.R.I.B.A., who has been kind enough to forward me some plates showing his design. It is executed with a framework of wood and covered with plaster. Parts of it are reproductions from Indian buildings.

For the buildings on the Champs de Mars I must refer you to the photographs, which are arranged in order, and which, I hope, will give you a very fair idea of the Exhibition. The habitations of man in all ages, by M. Charles Garnier, I have illustrated by a complete series of photographs. With the want of time, space, and money at M. Garnier's disposal, I think he ought to be congratulated on doing what he has done with so difficult a subject.

Before quitting the Quai d'Orsay, I should like to bring to your attention a little circular iron building, containing the Petroleum Exhibition. It is constructed of circular iron bands of sheet iron, 9 ft. long by 3 ft. 3 in., rivetted together with lead rivets in order to facilitate removing, but the most peculiar part of it is that it was built from the top to the bottom, the plates being held in position by strong cranes until the bottom plate was reached. This was done in order that the floods of the Seine during the spring should not wash the building away, there being practically no foundations.

I suppose one ought to say something of the Eiffel Tower, about which so much has been said and written. Mr. Hamerton's definition that "it is a land lighthouse prepared to resist the wind and not the waves," is probably as good a definition as can be found for it. As an engineering work there is nothing to be said against it, but it is inferior to the Forth Bridge, the total length of one of whose spans is twice the height of the Tower, and it also appears inferior to the Palais des Machines as a feat of engineering skill. It is no doubt, however, a wonderful structure in its way, and one cannot deny that the bold sweep of its four great legs, united at the base, and its circular arch, which, however, is not structural, is distinctly pleasing. Another great point is its extreme simplicity, only marred when the architect was called in to design the arcading to the two *étages*. Moreover, in looking at the tower we must remember that it is an extraordinary structure (using that word in its original sense), and that we cannot bring ordinary standards of beauty, —standards, we may say, which belong to stone or brick,—to bear upon a structure outside its range. For instance, the ordinary æsthetic principles we apply to a Greek temple or Gothic church, or a Queen Anne house, are totally inapplicable here, and we must not attempt to judge it by these rules. It was from trying to do this that the architectural, artistic, and literary world of France came such a "cropper," if you will allow me to say so. They had in their mind a solid-looking structure, towering with its black mass (like a factory chimney-shaft, as they said) 1,000 ft. in the air. They had never seen an Eiffel Tower, it being the first of its race (which we may hope will be a short-lived one), and they could not realise the graceful appearance of this lace-like monument, rising like a spider's web in the air, and crushing nothing, dwarfing nothing, by its graceful proportions; whereas a tower or lighthouse of stone or brick would do exactly what they said it would, it would crush and utterly destroy the architectural beauty of Paris.

There is no doubt that this open lace-work of the tower saves it from a failure, and I would strongly caution the powers that be to abstain from filling it with terra-cotta panels as has been suggested. This done the tower will indeed be a failure and an eyesore to Paris. The buildings on the Esplanade des Invalides are interesting, though not so much from a constructive point of view. The buildings, with some few exceptions, are devoted to the French colonies, to the Ministry of War, and to Sanitary Science, and are of a temporary nature. The colonial buildings are representative of the architecture indigenous to the various colonies, and are in this respect interesting, giving us real buildings, which in the majority of cases can only be seen by us on paper.

The Algerian Palace, Tunisian Palace, the Colonial Palace, the Annam and Tonkin Pavilion, and the Indo-China Pavilion are the principal buildings on the east side, and are constructed in *pan-de-bois*, or brick nogging.

On the west side is the Health Exhibition, the Ministry of War, the Post and Telegraph Pavilion. The construction of these latter is in some respects novel.

A very important material in use in the eastern building is clay, which, being burnt, and when in its plastic state has fragments of different coloured porcelains and marble embedded in it. This is then baked, and forms a very good constructional and decorative material. The Post and Telegraph Pavilion, by M. Boussard, is peculiar as having a large central hall, 49 ft. by 59 ft., roofed by means of wooden lattice framing bolted together and without a tie-rod.

Architectural Drawings.

In my report I have gone rather fully into the differences between the English and French schools of drawing. I suppose that there never has been a finer or a more representative collection of architectural drawings brought together in one exhibition. One of the chief differences is the large extent to which the French go in for classical restorations in which colour is largely introduced, the winners of the Prix-de-Rome being sent out to Greece and Rome for this purpose. English students, on the contrary, either stop at home to sketch or measure in black and white, or go on a foreign tour with the same object. Colour is the exception in the architectural drawings by English students. One sees comparatively few fresh drawings of old French work in the exhibition, and even these are all executed with colour. Another great point is the size of the French designs, and the absence of perspective which one meets in French work. The scale usually employed is two centimètres to the mètre, or $\frac{1}{50}$, which is practically equal to over $\frac{1}{4}$ in. scale to the foot, and for details five centimètres to the mètre, or $\frac{1}{10}$ full size, half full size also being used, and in all these details the shadows are carefully shown. The importance of the plan in comparison with the elevation is emphasised. In England this is not so in exhibitions. This, no doubt, is the fault of the Architectural Room at the Royal Academy.

The system of shadows and the absence of perspective naturally go together; one is not so much wanted where the other is employed. But it is this respect of shadow throwing which accounts to a large extent for the other differences as to scale, composition, &c. We can easily see, for example, that shadows on a small drawing are almost useless, the masses are not big enough to be appreciated. With regard to detail drawing, M. Dutert, M. Sédille, and other well-known French architects admitted that they could not understand how the English architect could design them without the help of shadows. Another point is the more complete study of the figure by French architects. Both of these differences are of course brought about by the early training. The decorative competitions held at the École des Beaux-Arts, in which painters, architects, and sculptors enter, of course necessitate the architect having a complete knowledge of the human figure. Then, again, one notices the absence of new domestic work at the Exposition, and what is there is bad. French country houses are designed, if I may say so, on the "square and high" principle instead of in the "long and low," which is the proper way to design a country-house, at any rate of small size.

The English and Americans have thoroughly grasped this fact. There is no doubt that the French system of shadows, and absence of perspective, so necessary in this class of work, is partly accountable for this. From the study of the French system, then, one would say that it works admirably for public buildings with large *façades* (especially when aided, as it so frequently is in France, by plaster models of the buildings to a large scale), and also for the preparation of details, but that for the designing of country residences, the English and American perspective system is to be preferred.

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obliged for various hints and introductions, as also the following architects:—M. Dutert (architect of the Palais des Machines); M. Formigé (architect to the two Art Palaces); M. Bouvard (architect of the central dome, &c.), and his "premier inspecteur," M. Ulysse Gravigny; M. Boussard (architect of the Post and Telegraph Pavilion); M. Yvon (architect of the Panorama du Tout Paris), M. Foulhoux (architect of the Annam and Tonkin Pavilion), M. Balla (the architect of the Argentine and Algerian Palaces), for the complete set of plans you see on the walls; M. Louis Dauvergne (architect of the Brazil Pavilion), M. Hermant (architect of the Portuguese Pavilion), M. Fonquiau (the architect of the Bolivia Pavilion), M. Ponpinel (architect of the Spanish Pavilion), and Mr. Charles Lucas, architect, and lastly for, but not least to, Monsieur Victor Contamin, the distinguished engineer, for all the great buildings on the Champs de Mars, for drawings and also for allowing his "premier inspecteur" to accompany me over the buildings. I am also obliged to M. Viollet-le-Duc fils for information as to the formation of the celebrated Museum of Comparative Sculpture founded by his father. And to various other French architects to the buildings in the Exposition, who, during my five weeks' stay in Paris, did all they could to assist me,

I think we ought to take an opportunity of showing our appreciation of our French *confrères*, who always show such a lively desire to help us in every way when we go amongst them.

Mr. R. Phené Spiers, in proposing a vote of thanks to Mr. Fletcher for his paper, said that with regard to the Galerie des Machines, he thought Mr. Fletcher had done right in departing from a simple description of the structure to point out that it was one of the great engineering feats of our time, and marked an epoch in engineering construction which was quite as remarkable in its way, if not more so, than that marked by the building of the great roof of the station at St. Pancras. As far as he understood the description of the roof, there was absolutely no tie to it, and the building owed its stability to its foundations, which extended so great a distance into the ground that a tie was unnecessary. He believed the idea of the articulated construction of the roof principals was M. Contamin's, though its arrangement was designed by M. Dutert. If so, he could understand how M. Dutert, having had to arrange the building, gave such artistic forms to the metal-work, producing the charming results which were to be found in the building. The central dome was one of those happy features which Frenchmen, uncontrolled by constructional difficulties and considerations of expense, were able to indulge in by the use of iron, filled in partially with canvas plaster. Speaking next of the Palais des Beaux-Arts, Mr. Phené Spiers said he thought that the external piers which Mr. Fletcher had described in detail were not satisfactory. They had the appearance of buttresses, but they were not constructional buttresses; they had not to carry a downward weight, but an outward thrust, and they looked weak. The series of buildings illustrating l'Histoire de l'Habitation, by M. C. Garnier, presented a good many interesting points, but there were some features to which exception should be taken. In fact, it was rather curious that M. Garnier made some errors which he might easily have avoided by a little more care and investigation. In the Hindoo House, for instance, to take only one case, the building was represented with two towers covered with what was known as the *chaitya*, which was a symbol of the Buddhist religion, and used only in the Buddhist temples. It was, indeed, a most sacred feature, and one which was never employed in domestic architecture. Other buildings of the series, however, particularly the Pompeian and Greek houses, were admirable, as might be imagined by all who were acquainted with M. Garnier's knowledge of Greek and Roman architecture. It was impossible to speak on the large subject which Mr. Fletcher had introduced with reference to the question of drawings. The collection of architectural drawings at the Paris Exhibition was of the most extraordinary kind, for it not only consisted of drawings executed during the last eleven years, but of drawings produced during the last century, and many of them by men such as Duban and others, whom France counted among her best architects. As water colourists, he thought the French architects of the early part of this century would take the palm from any who existed at the present day. He hoped they would pass a hearty vote of thanks to Mr. Fletcher for the pains which he had taken with his paper and for the admirable series of photographs and drawings which he had brought together.

Mr. H. W. Pratt, in seconding the vote of thanks, said he desired to propose a vote of thanks to the professional gentlemen in Paris who had kindly assisted Mr. Fletcher during his stay there. The Exhibition had shown them,—and he hoped the public had something of the same feeling,—that it had been not only an exhibition of articles and things inside the buildings, but that the buildings themselves had formed an exhibition which was alone well worth seeing. Hitherto what buildings had been erected for exhibitions had been more or less of a temporary character, and it was really marvellous to reflect on the amount of money which must have been spent on the substantial and, in some respects, beautiful buildings erected for the Paris Exhibition. Many of the buildings, though only serving a temporary purpose, had yet been erected in a permanent manner. The great use of iron and terra-cotta throughout the buildings was very noticeable, and he thought Mr. Fletcher had done well in bringing before them so minutely the details of some of the buildings. He must confess, however, that the curve of the large roof of the Galerie des Machines seemed to him to take a very unsatisfactory form, for the straighter portion of it was so straight that one could hardly believe there was any curve in it at all. He was glad that Mr. Fletcher had not wholly condemned the Eiffel Tower. Owing to preconceived notions, he certainly went to Paris expecting to see a monstrosity, and he was agreeably surprised to find that it was a much more graceful structure than he could possibly have imagined from its description. As one looked into the construction of the ironwork one was surprised to find how light that work was. The original design did not include the arches at the base, and to his mind those were the redeeming features of the design, pulling it together wonderfully. In looking at the detached buildings of the Exhibition representing different nationalities, and at the various parts of the buildings and galleries, one was struck with the way in which the French architects and engineers had worked together and had had the work subdivided. Whether the French Government was responsible for this or not, he thought it was a new departure, and one to be commended.

Mr. F. R. Farrow, in seconding the vote of thanks to the French architects and engineers who had assisted Mr. Fletcher, read a letter from Mr. Arthur Cates, who expressed his great regret at being unable to be present on account of illness, and his great satisfaction at the way in which Mr. Fletcher had fulfilled his duties as Cates Student. With regard to the construction of the roofs of the Exhibition buildings, by the use of articulated joints, it must not be supposed that the adoption of that method of construction was a new invention of the French; for a very good example was to be found in London,—the roof of "Olympia" having joints of articulated construction, somewhat similar to, although not precisely like, those mentioned by Mr. Fletcher. In "Olympia," however, the joints had not been left to be seen, but had been covered with ornaments supposed to be architectural.

Mr. F. G. Hooper supported the vote of thanks to the French architects. He had a bright recollection of their kindness to him during his stay in France last year, when holding the Godwin Bursary. Mr. Fletcher's paper, read that evening, and the much more detailed report which he had submitted to the Association, would, he thought, give great satisfaction to the donor of the prize. With regard to the exposure of the metal work of the French buildings, one was constantly hearing criticisms from the purists that if iron was used constructionally it should be visible. He did not know upon what ground the purists supported their contentions. The bones and sinews of the human body, that ideal of economic construction, were covered, but could not be criticised on that account. Hidden construction, gracefully covered, was surely quite as legitimate as the exposed ironwork which was seen at the Paris Exhibition in some of the permanent buildings. In architecture proper one of the characteristics should be durability, and a certain amount of monumental effect; and, although the French might have taught them something in the use of iron, they had not introduced a form of construction suited to the exigencies of a damp climate without a protection more efficacious than paint. The construction of these buildings was so extremely slender that engineers, he believed, had calculated the length of time that they would last, especially so with regard to the Eiffel Tower. The grant of land to the Eiffel Company, it was said, was for twenty years, and it had been estimated that the Tower would not outlive that time. Mr. Fletcher had referred to the architectural drawings in the Exhibition, and he wished to draw the attention of any likely to pay a visit to Paris to the drawings exhibited in one of the wings of the Trocadéro Palace, in which building was housed the collections of historical casts. Most of the historical monuments in France were under the protection of a Commission, to which body plans and drawings of the building had to be submitted before any work of restoration or alteration was commenced. Since the foundation of that Commission copies of all drawings made had been kept, and a very large number were exhibited in the Trocadéro Palace. This gave a good record of the buildings as they were before restoration, and also enabled them, if they questioned the authenticity of any feature introduced by a restorer, to trace, as far as possible, the data in the possession of the architect when carrying out his work.

Mr. Cole, in supporting the vote of thanks, said that as regards the use of iron, he thought it might be laid down as a principle that its exposure inside a building was a good feature, but used outside its exposure was bad, as it was injuriously affected by the weather.

Mr. Wilfrid Stokes said he thought they would all be struck with the amount of sameness in the main features of the roofing of the Exhibition. With regard to the Galerie des Machines, it was generally supposed, but he thought wrongly, that some sort of magic had been invoked for the design of its vast roof. From his point of view (speaking as an engineer) there was nothing new in the design except its size and possibly its proportions; while he thought it would be quite obvious to any engineer that the lattice-work of the roof-principals was not very scientifically designed. With regard to the Eiffel Tower, he was agreeably surprised with its appearance, and it created a favourable impression in him, but he did not think the kind of bird-cage at the top was satisfactory.

Mr. A. O. Collard said, with regard to the question of the amalgamation of architects and engineers, the matter had often been discussed, but had long been practically settled, and such were the exigencies of the times that it would now, he thought, be impossible to combine the two professions. He trusted that the Eiffel Tower would not have a numerous progeny, but he was told that the Watkin Tower would be more pleasing to the eye and be a more original scheme than the Eiffel Tower, as well as combining art with utility.

The President said that he agreed with Mr. Pratt's remarks about the curve of the roof of the Machinery Hall not being satisfactory. The only way to treat ironwork satisfactorily was to get the lines right and to give it a broad, simple treatment, with good proportion, if possible. Ornament, when applied to ironwork, never seemed satisfactory, and the only ironwork which he had ever seen which was really satisfactory was simply constructional. He could not agree with Mr. Hooper as to the desirability of covering up the iron construction; nor could he join Mr. Fletcher in his admiration of the central dome of the Exhibition, the two domes of the Palais des Beaux-Arts and the Palais des Arts Libéraux being, in his opinion, in far better taste, though not so large. He could not help thinking that if the Eiffel Tower had been erected for some particular purpose it would have been a much more satisfactory work. If its engineers thought they had put up an ornamental structure, he could not agree with them; but if it was merely intended to show how to get up to a great height to take observations, it might be regarded as a success. He agreed with Mr. Fletcher thoroughly in the way in which he had spoken of the treatment of the iron and terra-cotta as panels in the Exhibition buildings.

The vote of thanks to the French architects and engineers who had assisted Mr. Fletcher was put first, and carried by acclamation.

Mr. Banister F. Fletcher, in reply to

the vote of thanks to himself, said that nearly all the points which had been raised about the roof of the Machine Gallery had been gone into fully in his report. In that report they would see it stated that M. Dutert designed the roof of that building, and he was also responsible for the design of the lattice work. The articulated jointing of the roof was a feature which, he believed, had been used for some time by M. Contamin in the construction of railway bridges in France. Many of the iron buildings forming part of the Exhibition were not temporary structures at all; some of them were to be left standing, and others, such as the building of the Argentine Republic, were to be taken down, transported, and re-erected in the countries whose arts and industries they had served to exhibit.

THE INSTITUTION OF CIVIL ENGINEERS:

THE PRESIDENT'S ADDRESS.

At the first ordinary meeting of the session, on Tuesday, November 12, the President, Sir John Coode, K.C.M.G., delivered an inaugural address, it being the first occasion of his occupying the chair at an ordinary meeting since his election as President. After referring to the growth of the Institution, from about 600 when he joined it as a member in 1849 to approximately 6,000 at the present time, he alluded to the visit of the American engineering societies soon after the close of the last session, and the leading part taken by the Institution in their reception and entertainment.

When considering the question of a topic for his address, it appeared to him that the experience gained during three lengthened professional visits to distant parts of the British Empire might not be unsuitably drawn upon, the visits involving journeyings of more than 75,000 miles. The text of his subject was:—"British Colonies as fields for the employment of the Civil Engineer." By the term colony was strictly meant a country, or portion of a country, inhabited by a people who had gone forth from their mother-land, and had made that country their home, though remaining more or less directly under the government of the country from which they or their ancestors had originally emigrated. These might be said to be British dependencies, held mainly for strategic purposes, in which the British element in the population was very small, such as Gibraltar, Malta, Cyprus, and Heligoland; dependencies under the British Crown chiefly used as trading stations, but also serving as coaling stations, and for repairing steamers of the mercantile marine or ships of the Royal Navy, such as Singapore and Hong-Kong; colonies which were exporters of their own produce on a large scale, such as the West India Islands, Mauritius, and Ceylon; and colonies proper, as Canada, Australia, South Africa, and New Zealand. The key-note to the colonial question was best represented by the single word "transport." Wherever there was trade, there would of necessity be a demand for the means of transport, and where there was a demand for the means of transport there would be found a need for the works of the civil engineer. Whilst the population of the world had increased by a little less than 10 per cent. between 1870 and 1880, the increase in transport within the same period had been fully 53 per cent. The connexion was obvious between transport and the several engineering works comprehended under the construction of railways, tramways, roads, canals, harbours, docks, steam-ships, locomotives, bridges, viaducts, aqueducts, tunnels, waterworks, gasworks, sewage works, and irrigation channels: breakwaters and lighthouses might be included within this same category, and he ventured to affirm that this factor of transport pervaded the domain of electric telegraphy. Harbours and docks assumed a special importance in connexion with our colonies. As respected external trade, they formed the terminal links of the great chains of communication which served to bind them to the mother country. As regarded our larger colonies, the practice had been to extend the roads and railways from the sea-ports back into the interior, with the result that the land lines of communication parallel to the coast had been as yet but little developed, and much the larger proportion of the traffic between different parts of the same colony was sea-borne. Hence in most of our colonies, harbours and navigable rivers assumed greater importance in the matter of transport than was generally assigned to them in the mother country.

After dealing with the means of reaching the colonies, he said that one result of recent improvements in steam-ship building was a reduction in the cost of ocean transport. The cost of the freight of heavy goods, such as unmanufactured iron, say to Sydney, a distance of nearly 12,000 miles from England, was about 25*l.* per ton twenty years ago, whereas recently it had been as low as £1. 10*s.* a ton, or a little more than $\frac{1}{3}$*d.* per ton per mile, and the saving in distance by the Suez Canal route as compared with the route by the Cape was only about one-ninth of the whole distance.

The President then entered into the statistics of the chief engineering works which had been, or were being, carried out in British colonies, and the scope which existed in those colonies for the future employment of civil engineers, giving their position, general configuration, and physical features, area and population, climate, industrial products, and mineral wealth; and public works, whether executed, in progress, or contemplated in the immediate future. Canada, the largest of the colonial dependencies of Great Britain, had an area of 3,610,000 square miles, of which 140,000 square miles were covered with water, and the system of inland navigation was the largest in the world. The St. Lawrence alone, in conjunction with the great lakes, afforded unbroken water communication to Port Arthur and Duluth from Liverpool. The total length of railways in the Dominion was about 14,000 miles, and the area of territory in the Dominion per lineal mile of railway was in the proportion of 258 to 1. Although completed thirty years ago, the Victoria Bridge across the River St. Lawrence still remained one of the finest engineering works of the last half-century; and the ship-canal in the St. Lawrence, 27½ ft. deep, completed twelve months ago, had a very important bearing upon the commercial prosperity of the Dominion, enabling merchant steam-ships of the largest class to reach Montreal. Two large graving-docks had been constructed, one at Esquimalt in British Columbia, and the other at Halifax in Nova Scotia, while a ship-railway, 17 miles long, was being laid for the transport of vessels across the isthmus which connected Nova Scotia with New Brunswick. . . . . In New Zealand, 1,750 miles of railway had been completed up to the end of March, 1888, giving one lineal mile of railway to fifty-nine square miles of territory. Breakwaters and training banks were being constructed for the improvement of the entrance of the River Buller at Westport, and similar works were in progress at Greymouth. A new graving-dock had lately been completed at Auckland, 500 ft. long and 80 ft. wide, with a depth of 33 ft. of water over the sill at spring-tides. Otago harbour entrance had been improved, and a harbour created at Lyttleton, near Christchurch, enclosing an area of about 112 acres, with jetties and wharves having a length of berthage of 11,000 ft., with lines of railways in connexion with the general system of the island. The depth of water within the harbour varied from 19 ft. to 25 ft. at low-water. In Tasmania, 440 miles of railway had been opened at the end of 1887, being one lineal mile of railway to fifty-five square miles of country. Sir John Coode then referred to Australia, treating it first as a whole, and afterwards dealing separately with the five colonies into which it was divided. It was about six-sevenths of the size of Canada, and only about one-fifth smaller than the continent of Europe. An index of its magnitude was to be found in the size of the catchment basin of the River Murray and its tributaries, the area of which was 510,000 square miles, or nearly six times greater than great Britain. In Western Australia, with a population of only one inhabitant to twenty-five square miles, there were 450 miles of railway, or one lineal mile for each 2,375 square miles of territory. In South Australia, at the end of 1888, there had been constructed 1,820 miles of railway, or one mile to 496 square miles of land. At Port Adelaide there was a total wharf frontage of about 13,000 ft., and the channel leading up to the port from the sea had been deepened from 9½ ft. to 22 ft. at low-water. The works for the water-supply of Adelaide were of a very extensive character, and when completed would include a storage reservoir of 2,760,000,000 gallons capacity. Victoria, the smallest colony in Australia, had 2,200 miles of railway in operation at the end of 1888, being one lineal mile to forty square miles of area. As an instance of the wonderful growth of the city of Melbourne, the capital of the colony, the President stated that little more than fifty years ago a corner plot of land, near the centre of the city, was sold from a tree-stump as a rostrum for 45*l.*, and that the same plot, with the buildings upon it, had just been valued at 493,500*l.* Until recently, the navigation from the head of the bay, by the River Yarra-Yarra to the city, a distance of 6¾ miles, was through a narrow, tortuous channel. This had been greatly improved by training-works and the cutting of a canal, and the navigation was now through a channel 5½ miles in length, and when completed would have a depth of 20 ft. and bottom width of 150 ft. The storage capacity of the Yan Yeam reservoir, for the water-supply of Melbourne, was 6,400,000 gallons, the expenditure on the system had exceeded £2,500,000, and further works were in progress. Irrigation on a large scale had been fostered by the Government of Victoria, the area intended to be irrigated amounting to nearly 1,250,000 acres. In New South Wales, at the end of 1888, 2,160 miles of railway were open, being one lineal mile to 144 square miles of country. The length of the great bridge over the Hawkesbury River, which formed the last link in the continuous railway system between the principal cities of the four colonies of South Australia, Victoria, New South Wales, and Queensland, was 2,900 feet between the abutments, and the foundations of the several piers, six in number, were carried to depths varying from 101 ft. to 162 ft. below high-water level. The President then referred to the recently-constructed graving-dock on Cockatoo Island, in the harbour of Sydney, 600 ft. long and 84 ft. wide, to the Macquarie lighthouse at the entrance to Port Jackson, to the water-supply of Sydney, and to the works at Newcastle, at the mouth of the Hunter River, the great coal-shipping port of the colony. In Queensland, the returns up to the end of 1887 showed that 1,770 miles of railway were open, or one lineal mile to 378 miles of area. River improvements had been effected in the channel leading up to Brisbane, at the Fitzroy River from the sea up to the town of Rockhampton, at the entrance of the Pioneer River, and also at the entrance to Norman River in the Gulf of Carpentaria. As an instance of the mineral wealth of this colony, the Mount Morgan Mine, near Rockhampton, was now turning out gold to the value of 128,000*l.* per month, of which 28,000*l.* went in working expenses, and the balance in dividends to the shareholders.

The President then observed that the questions naturally arose: "Whether the colonies had been justified in constructing public works? and whether they were capable of bearing the financial obligations they had thereby imposed upon themselves? To these questions, he said, circumstances warranted a reply in the affirmative; taken as a whole, the market value of the public works already executed by the colonies would be fully equal to their cost. The earlier settlers had in many cases been brought face to face with large and pressing demands, for the execution of such public works as had been absolutely essential for securing ready inter-communication between district and district, more especially between the sea-board and the interior, involving roads, railways, &c., within their own borders, and between themselves and the outer world. Further, in not a few instances, our colonies have found it absolutely necessary to incur a considerable annual expenditure on subsidies to ocean-going steam-ships, to insure frequent, regular, and rapid communication with the rest of the world. The question whether our colonies were capable of bearing their financial burdens could only be answered in general terms; but perhaps the most conclusive reply in the affirmative was to be found in the readiness with which invitations by British colonies for large loans were met in the "Money Market" of the City of London. It was doubtless not overlooked that in the larger colonies vast areas of land were yet unappropriated, and formed so much capital in reserve. Moreover, in the case of some of the government lands occupied by squatters, the rentals were subject to a percentage of increase periodically. Further, the financial position, and consequently the spending power, of the colonies was favourably affected by the present low rate of interest obtainable for capital in this country. Many were now able to raise loans at 3½ per cent. which not so very long ago found it necessary to offer 6 per cent. While our own

country had for the last three hundred years been steadily building up a great Empire by the acquisition of colonial possessions, it was only within the last decade that any other European State had taken action of importance in the matter of colonisation. It was also worthy of remark that, within those portions of the world possessing such a climate as to admit of the employment of white labour upon out-door operations, there was not now a single region of any magnitude available for colonisation, and that no inconsiderable part of the area of the globe was under the imperial ægis of Britain. In concluding, Sir John Coode spoke of the capabilities and possibilities yet to be developed by the civil engineer, whether in the colonies or in the mother country. The field was indeed a vast one; great advances had recently been made, and were still being made, in every branch of engineering. Notwithstanding, he would be rash who would venture to prescribe a limit to engineering achievements. He was convinced that as long as the present dispensation might last, so long would there be a continuous progress in the science and practice of every branch of labour in the field appertaining to the civil engineer. Neither to the engineer, nor, indeed, to any other disciple of natural science, would it seem to have been announced, "Thus far shalt thou go, but no farther."

THE LONDON COUNTY COUNCIL.

THE ordinary weekly meeting of this Council was held at the Guildhall on Tuesday afternoon, Lord Rosebery in the chair.

The Vacant Chief Engineership.—The report of the Committee tentatively appointed at the previous meeting (see last week's *Builder*, p. 351) to consider the steps necessary to be taken for filling the vacancy caused by the death of Mr. Joseph Gordon, reported as follows:—"Your Committee have to report that they have considered the subject of the appointment of an Engineer to fill the vacancy caused by the death of Mr. Gordon. They have had before them several candidates, and, as a result, they submit the names of Mr. F. E. Duckham, Mr. J. W. Girdlestone, and Mr. A. R. Binnie, and recommend—

"'That Mr. Duckham be appointed Chief Engineer of the Council at a salary of 1,500*l.* a year, upon the following conditions:—That he do hold his office during the pleasure of the Council; that he be required to give his whole time to the duties of his office, and be not allowed to take any private practice; and that on retirement he shall not be entitled to any superannuation or pension.'"

This recommendation gave rise to a long and acrimonious discussion, it being asserted, in opposition to the Committee's recommendation, that Mr. Duckham, although no doubt a competent dock engineer, had had little or no experience of sewerage work. Furthermore, it was alleged that to appoint Mr. Duckham to the vacant post would be to perpetrate something very like a job, inasmuch as his friends on the Council (one or two of them relatives) had systematically touted for votes on his behalf. In reply to the cry of "Names!" Mr. John Burns, who made the latter allegation, said that the Councillors he referred to were Mr. McDougall and Mr. Lidgett. Mr. McDougall was stated to be the brother-in-law of Mr. Duckham, and Mr. Lidgett was said to be his father-in-law. Mr. McDougall admitted the relationship, but denied that he had asked anyone to vote for Mr. Duckham. Mr. Lidgett, while not denying that he had voted for Mr. Duckham on the Committee, denied that he was Mr. Duckham's father-in-law. It was contended that several of the candidates who presented themselves on the last occasion, such as the City Engineers of Liverpool, Manchester, Bradford, and other towns, were much more eligible candidates for the appointment than Mr. Duckham. Eventually, an amendment, moved by Mr. Collard, and seconded by Mr. Rhodes, the ex-Chairman of the Main Drainage Committee, to refer the matter to the Standing Committee, was carried by a large majority.

Building Works at Cane Hill Asylum, Coulsdon.—The Asylums Committee reported that they had proceeded upon the resolution of the Council of the 12th inst. (see last week's *Builder*), referring back to the Committee their report of the 5th inst., recommending the acceptance of the tender of Messrs. Peto Bros. for the execution of the works for the extension of Cane-hill Asylum, for the sum of £82,447, with instructions to accept such tender, as amended by Messrs. Peto owing to the rise in the price of building materials since September 30, the date of the presentation of the tender, and had accepted such tender amended by the addition of the sum of £1,400. The Committee now submitted the contract for the execution of the work, and recommended—

"That the contract with Messrs. Peto Bros., for the execution of the works for the extension of the County of London Asylum for pauper lunatics, at Cane-hill, Coulsdon, for the sum of £83,847, be approved, and that the contract be sealed."

This was agreed, to after considerable discussion.

The Site of Millbank Prison.—Earl Compton moved the adoption of the report of the Housing of the Working Classes Committee, in which a statement occurred with reference to the Millbank prison site. It would be remembered, the Committee said, that the site occupied between twenty-two and twenty-three acres, and that the third section of the Housing of the Working Classes Act, 1885, gave power to the Secretary of State to sell the site to the Metropolitan Board of Works at a fair market price. At the date of their last report the Committee had received no reply from the Secretary of State to their inquiries as to the price of the land, but they had now received a communication from the Home Office, stating that it was not possible to name a price applicable to all portions of the site, inasmuch as the "fair market price" varied with the situation and advantages of frontage. The Secretary of State, however, suggested that the Council should acquaint him with the amount of land required for the erection of artisans' dwellings, when a fair valuation might be arrived at by surveyors to be named by the Council and the Secretary of State. The Committee instructed the Architect to make a careful valuation of the whole site, and they had received from him a report, pointing out the uncertainty of any estimate, caused by the disproportion between the area and its frontage, which would render it necessary to construct new roads and approaches, and also by the exceptional character of the foundations. The Committee, after full consideration of the whole question, were of opinion that it would not be desirable, having regard to the character of the site and the cost involved, owing to the state of the foundations, for the Council to acquire the whole area for the purpose of artisans' dwellings, but that if eight acres could be secured at a price not exceeding 2,000*l.* an acre, it would be most desirable that provision should be made for erecting artisans' dwellings thereon, and accordingly they recommended:—

"That a letter be addressed to the Secretary of State, inquiring whether her Majesty's Government would be willing to dispose of eight acres of the site, for the erection of artisans' dwellings, at the price of 2,000*l.* an acre."

A long discussion took place on this recommendation, which, after an amendment,—suggesting that the Council should endeavour to acquire the whole of the site,—had been rejected, was ultimately agreed to.

After the transaction of further business the Council adjourned.

ARCHITECTURAL SOCIETIES.

Birmingham Architectural Association.—A meeting of the Birmingham Architectural Association was held on the 19th inst., in the small lecture theatre of the Midland Institute, when Mr. G. A. T. Middleton delivered a lecture, entitled "The History of England written in Stone." The lecturer illustrated his remarks with photographs of Stonehenge, Porchester Castle, Sompting Church, Tower of London, St. Botolph's Priory; Colchester, Durham, Chichester, Ely, Salisbury, and Lincoln Cathedrals; Tewkesbury Abbey, Haddon Hall, and other historic buildings.

Manchester Architectural Association.—The second ordinary meeting was held on the 19th inst., at the Diocesan Buildings, Mr. J. H. Woodhouse (President) in the chair. Mr. F. M. Simpson, of London, read a paper on "Old House Work," in which he said the difficulty in treating a subject like this was to decide upon what head to attack, but for the present he would confine his remarks to England. The rude accommodation of the twelfth century was described, and its gradual development traced up to the present time. The most marked improvement in house-planning began in Elizabeth's reign, but the hall continued to be the principal feature of the house until the Gothic revival. About the seventeenth century we find traces of the foreigner having worked side by side with the English workman. A vote of thanks was proposed by Mr. Davies-Colley, seconded by Mr. J. S. Hodgson, and supported by the President and Mr. Mee.

The Student's Column.

WATER-SUPPLY.—XXI.

THE ESTIMATION OF THICKNESS OF STRATA IN PROPOSED WELLS.

THE student of hydrogeology ought, under certain circumstances, to be able to predict the thickness and nature of strata which will be passed through in proposed well-borings, especially when these latter are only to be of moderate depth; and our present object is to discuss the methods by which tolerably accurate estimates may be arrived at.

The subject naturally divides itself into two parts,—(1) where the boring is to be in a town or city, and (2) in the country. Let us firstly consider the former, and, in continuation of our remarks on London water-supply, proceed with reference to a proposed well-boring in the metropolis.

Probably no city in the United Kingdom has had so many wells constructed as London, and the materials at hand for arriving at the thickness of the strata under any part of the metropolis are enormous. In the last two articles we have given a few particulars concerning the depths of London wells, together with the thicknesses and nature of the different strata passed through, and this was enough to indicate the general disposition of the strata. But, however useful that might be, in imparting a general idea of the substructure of the metropolitan area (a very necessary preliminary in the study of private water-supply), it does not go very far to show the student how to accurately estimate the thickness under any given site. To find this it is necessary, firstly, to examine the records of well-borings, and these will be found in certain works on geology, now to be alluded to.

The records of borings in the London district, whether successful or not in finding water, have been for many years perseveringly collected by one geologist, Mr. Wm. Whitaker, F.R.S., Director of the Geological Survey, and the student is referred to the writings of that gentleman for full information on the subject. His most important work in reference to it has only just left the press. It is a Government publication, in two volumes, issued as a "Memoir of the Geological Survey," entitled "The Geology of London and of part of the Thames Valley." Vol. I., Descriptive Geology; Vol. II., Appendices (wells, borings, &c.). The latter is the most useful volume for the subject in hand, and can be bought separately. A glance at it shows that there are hardly any main thoroughfares and but few side streets in London in the houses of which, at some time or another, wells have not been constructed. Another work by the same author dealing with a more extended tract of country, chiefly the southern and western part of the London basin, is also very useful, and is entitled "Memoirs of the Geological Survey, &c.," vol. iv., part I. (1872). He has written, in addition to the above, several pamphlets, giving details of borings in various parts of the home counties, all of which have a special value, but which are, unfortunately, almost buried in the "Proceedings" of provincial societies. Occasionally, on the production of a Government "Memoir," they are unearthed, however, and made more available to the professional public. We should not enlarge so much on these publications, only that they are very little heard of by practical men, owing mainly, we believe, to the well-known apathy and neglect of general business principles on the part of certain departments of the Government. These books, especially the first-mentioned, are absolutely indispensable to architects and engineers studying the water-supply of the metropolis and the outlying parts of the Tertiary basin.

Having fixed on a site for a proposed well in London, the first thing is to find its height above Ordnance datum, which can be done approximately on reference to large-scale Ordnance maps. Then refer to the Geological Survey Memoir, to which we have just alluded, and in the Appendix, search for particulars of all the wells within a reasonable distance (say, within a radius of half a mile) of the site, and plot their positions on the map, accurately

noting in each case their height above Ordnance datum also. The Geological map (6 in. to one mile) of the district should now be consulted to ascertain the boundary of any drift, superficial accumulations, or "solid" strata, if any of these limitations come within the area concerned. We next prepare to draw a section to scale, commencing, of course, by making a datum line, and plot on it the heights of the surface of the ground of the various sites of the wells (found within the half-mile radius), and their distances from each other, making the sections pass, as near as possible, through the site of the proposed well. Three or four sections may be drawn, including as many wells as possible along each line of route taken. Join the heights above Ordnance datum together, whilst consulting the Ordnance map, and then it will be seen that we have drawn in section an approximate contour of the surface of the ground between each well-boring, with the site of the proposed boring in the centre. Note on the contour line the exact position of any geological boundary-line as derived from the geological survey map. Now, take in succession the account of each boring from the memoir, and from the respective sites on the contour line drop a line (vertical to the datum line) representing the depth of each well from the surface. Then observe the thicknesses of the important strata passed through by the borings in every case, and, commencing from the contour line, mark them off, to scale, along the verticals. It will now be seen that each vertical has marked on it the depth (from the surface of the ground) of the limits of thickness of each important stratum met with in the particular boring represented by the line. Join the respective limits together. For example, draw a line through all the points indicating the base of the London clay, or representing, say, the top of the chalk. Also join up the limits of any geological boundary line shown on the contour line, and be very careful to be accurate in regard to this, should the lines come anywhere near the centre of the area. It may be found that some of the strata met with in the borings crop out at the surface within the area. Where this is the case, the boundary lines (if any) indicating the limits of such outcrops must be connected with the strata to which they refer on the verticals representing the wells in question. We are now presented with geological sections surrounding and passing through the position of the proposed well; the dip and general disposition of the beds are clearly shown, and all we have to do to estimate the thickness of the strata which will be passed through at the desired spot, is to drop a vertical from the site on the surface contour, down through each section, to the proposed seat of supply, and measure the respective depths at which the limits of the different beds are met with on it. Then compare the thickness of each stratum as derived from the sections, and draw up an average thickness from the data obtained. For example, suppose we have drawn three sections, we shall get three accounts of the strata to be encountered in our proposed well, and all these will differ slightly from each other. The Woolwich and Reading series may be indicated, say, as 54 ft. thick in one section, 52 ft. in another, and 49 ft. in the third. On striking an average between these, we find we should have, as nearly as possible, 51 ft. 8 in. of this series to pass through, and so on. In drawing geological sections it is usual, for obvious reasons, to exaggerate the vertical scale in comparison with the horizontal, though the less this is done in practice the better.

The foregoing method of estimating thickness only applies to large cities, where a number of wells have already been sunk. By way of illustration, we have taken a most simple case,—that of constructing a well in the metropolis; and what we have said holds good for London and suburbs. The underground structure of the metropolis is so simple that a very small modicum of pure geology suffices to enable the student to work out the details in the manner described,—it is really only a matter of draughtsmanship. But something more is required when we are dealing with a district in which the strata are much complicated, or where well sections are few and far between. In these cases the evidence derivable from existing wells is of comparatively little use,—in fact, it is often misleading. It is true we must take advantage of all the sections we can muster, whether natural or artificial, but we cannot treat them in quite the same manner as in the London area. In such instances we have to know a great deal about the pure geology of the district; we must be able to trace the direction, inclination, and influence of faults or dislocations, and the regional curvature and local contortions of the strata surrounding the site of the proposed wells, together with many other matters of a technical nature, especially those dealing with the influence of the irregularity of unconformities in the distribution, thickness, and nature of the formations. These problems the non-geological student cannot hope to solve without much previous training in the details of the science, and it is not within our province to do more than just refer to anything of so technical a nature. We can only deal with the more apparent and practical side of the question.

At the same time, we may mention the fact that Mr. Whitaker has obtained particulars of a very large number of wells all over the kingdom, and that accounts of some of them will be found in the appendices to most of the official memoirs describing the different geological maps issued in recent years.

In certain parts of the country the structural geology is not much more difficult to understand than that of the London area, and, although it may not always be possible to estimate the thickness of strata to be passed through in a proposed well so accurately as in that area, the appendices in such cases are useful in assisting us to form an approximate idea, and especially if the site happens to be very close to some of the recorded wells. In districts where the strata are not much complicated, and where the proposed well is to be near a large surface section, such as a cliff or quarry, and no other evidence is at hand, care should be taken to observe the dip of the strata, and the distance of the well site from the exposure. After ascertaining this distance and the angle of dip, the thickness of strata to be met with may be calculated by slightly adapting the methods described by Mr. Ralph Tate, F.G.S., in "Physical Geology" (1879), pp. 119 *et seq.*

RECENT PATENTS.

ABSTRACTS OF SPECIFICATIONS.

17,823, Improved Closet for Ships' use. J. Carter.

The closets which are the subject of this patent have one or two valves, these valves to be opened or shut as required by a sort of rack and pinion, one end being attached to, or working on, the valve-shaft, and the other end to the handle or pull-up. By this arrangement, when the handle is raised, the top valve is opened, and its contents discharged into the bottom compartment, and upon the handle being pushed down to its lowest position, the top valve is again closed previous to the opening of the bottom valve. Upon the bottom valve being opened, contents that were formerly in the top apartment are passed into the drain, and all bad smells are avoided. Suitable mechanism for effecting the aforesaid purposes is described in the specification.

18,584, Gas-service and Fittings-cleansers. W. Fiddes and W. Stagg.

This invention relates to an improved form of air force-pump, designed to cheaply effect the same purpose as those of more expensive pattern at present in use for the same purpose.

13,774, Wood Substitute. C. O. Thielemann (Freiburg).

According to this invention, a material designated hornite by the inventor is made from waste pieces of wood which are disintegrated and mixed with lime well kneaded up into a paste, and then poured into moulds and allowed to harden under pressure for about two hours, and then dried in the open, when it becomes hard and tough like bone. The inventor particularly applies the material for use in making coffins.

14,282, Door-bell. H. Leach.

This invention relates to a bell actuated by mechanical means so arranged as to bring about the same result and be the same in appearance as an electric bell. Thus a small push-button is made to actuate a rod connected with the alarm mechanism which will ring as long as the button is pressed. The bell is really struck by a hammer controlled by clock-work concealed within its circumference or dome.

14,664, Door-bell. A. F. Rockwell.

This patent relates to an American device for an exactly similar purpose to the foregoing; but the mechanism is slightly different, and the invention is here carried a point farther, for provision is made for working the bells by means of levers and cranks at any distance from the door.

NEW APPLICATIONS FOR PATENTS.

Nov. 4.—17,447, E. Christie, Combined Door Chain and Latch.—17,453, F. Baker, Flush-bolts.—17,497, F. Cowley, Attaching Door-knobs or Handles to Spindles.

Nov. 5.—17,531, G. Cheetham, Automatically Securing Windows in any Position.—17,560, S. Adams, Automatic Cisterns.—17,589, J. Hearth, Fastener for Window-sashes, Doors, &c.

Nov. 6.—17,640, W. Thompson, Artificial Stone.—17,653, S. Hill and R. Hodges, Locks and Fastenings for Doors, Cupboards, &c.—17,665, J. Keighley, Chimney-pot or Ventilator.—17,666, J. Empson and others, Valves for Cisterns, &c.—17,670, C. Grimmett and J. Simpson, Fastenings for Window-sashes, &c.—17,700, J. Thomas and others, Ventilation, Smoke Prevention, &c.—17,705, J. Braidwood and J. Johnston, Fireproof Construction for Buildings.—17,706, Millar's Patent Window Co. and H. Millar, Holding or Securing Reversible Window-frames.

Nov. 7.—17,712, T. Bradley, Bench-stops or Hooks for Joiners' Benches, &c.—17,752, T. Collins, Hanging-irons for use with Ladders.—17,758, H. Bassett, Building Material.—17,775, E. Killick, Drying-chambers of Kilns.—17,779, A. Rammage, Novel Construction or Build-up of Iron Breast-summers and Girders.

Nov. 8.—17,809, J. Pye, Water-taps.

Nov. 9.—17,904, J. Ganzert and I. Schiel, Adjusting and Fixing Ventilating Windows, &c.—17,908, S. Warr, Ornamental Bricks or Mouldings, &c.

PROVISIONAL SPECIFICATIONS ACCEPTED.

14,488, J. & A. Duckett, Waste-water Closets.—15,115, W. Joy, Manufacture of Cement, &c.—15,140, J. Kaye, Handles for Doors.—15,171, C. Gabriel, Cisterns for Flushing Water-closets.—15,303, W. Moseley, Electric Bells.—15,510, G. Notton, Filtering Cisterns.—15,717, J. Macky and J. Mitchell, Nails.—15,884, H. Dixon, Veneering Pianoforte Cases.—16,183, H. Smith, Fastener for Window-sashes, &c.—16,218, M. Rogers, Securing Window-sashes in any required position.—16,301, S. Hill, Door-closing Springs and Checks.—16,335, W. Bird, Self-closing Door Apparatus.—16,398, F. Stewart, Mitre Clamps.—16,527, W. Meakin, Attaching Sash-lines to Sashes.—16,651, L. Groth, Brazing Band-saws.—16,752, J. Jofch, Checking Workmen's Time.—16,804, J. Wilson, Nail.—16,860, E. Urry and G. Farini, Closing Doors.—17,211, W. Akerman, Kilns, &c.

COMPLETE SPECIFICATIONS ACCEPTED.

Open to Opposition for Two Months.

15,920, J. Lightbody, Water-cisterns, &c.—17,839, J. Cole, Ventilating Sash-fastener.—18,705, H. Condy, White Lead.—195, J. Greathead, Tunnelling Apparatus.—198, A. Vingner, Hydraulic Lifts or Hoists.—12,397, H. Owens, Opening, Closing, and Securing Movable Casements, &c.—13,004, J. Routledge, Sash Fastener.—15,523, J. Connell, Ventilators.—15,669, J. Erslev, Artificial Asphalte.

RECENT SALES OF PROPERTY:

ESTATE EXCHANGE REPORT.

Nov. 11.—By C. W. Millar.

Portman-sq.—72, 74, and 86, George-st., u.t. 33 yrs., g.r. £103, r. £250 p.a.	£1,800
Dalston—L.g.r. of £21, u.t. 48 yrs.	365
Islington—F.g.r. of £21, with reversion in 68 yrs., to e.r. of £135	540
F.g.r. of £26, with reversion in 65 yrs. to e.r. of £125	595

By A. Chancellor.—At Richmond

Richmond, George-st.—"The Rose and Crown" public-house, f.	2,500
Marshgate-rd.—A plot of f. land, area 570 ft.	820
39, George-st.—f., area 590 ft.	970
"The Tower House," f., e.r. £100 p.a.	1,250
2, Heron-ct., f., r. £120 p.a.	2,000
Two f. boathouses, r. £80 p.a.	1,000
F. livery premises and business premises in Hill-st., r. £80 p.a.	1,420

Nov. 12.—By Broad & Wiltshire.

Farringdon-rd.—Nos. 83, 85, and 87, u.t. 77 yrs., g.r. £300, e.r. £1,200	6,070

By L. G. Lewis.

Upper Berkeley-st.—No. 77, u.t. 35 yrs., g.r. £11. 11s., r. £150	1,690
Chelsea—43, Smith-st., f., r. £50 p.a.	1,030

By J. & A. W. Tharp.

Hackney—29 to 35 (odd), Clarence-rd., u.t., 49 yrs., g.r. £12	950

By Driver & Co.

Leicester-sq.—No. 31; and 1, Green-st., f., area 1,070 ft.	3,325
8, Green-st., f., r. £80 p.a.	1,925
17, Bear-st., f., r. £85 p.a.	1,700
Kensington—Palace Gardens-ter., i.g.r. of £60 a year, u.t. 64 yrs., subject to g.r. of £8	1,130

By Montagu & Robinson.

Spitalfields—18 and 19, Church-st., f., e.r. £160 p.a.	2,600
Bermondsey—48 and 50, Esmeralda-rd., u.t. 51 yrs., g.r. £10, r. £59	565
52 and 54, Reverdy-rd., u.t. 50 yrs., g.r. £9, r. £62	610
77, Fort-rd., u.t. 40 yrs., g.r. £4, r. £31	300

By VENTON, BULL, & COOPER.
Barbican—"Staines House," f., area 1,350 ft. £3,520
Wood Green, Mayes-rd.—"Waverley House," f.... 610

By P. D. TUCKETT.
Hyde Pk.—112, Westbourne-ter., u.t. 48 yrs., g.r. £24, r. £250 2,500

Nov. 13.—By H. DONALDSON.
Bow—2 and 4, British-st., f., r. £52 700
Lower Clapton—35 to 43, Luckhurst-st., u.t. 84 yrs., g.r. £1. 5s. 655
Islington—14, Oakley-rd., u.t. 49 yrs., g.r. £6, £45 p.a. 375
Sydenham—F.g.r. of £40, with reversion in 48 yrs. to e.r. of £140 850

By WARD & CLARKE.
Chelsea—60 and 62, College-pl., u.t. 19 yrs., g.r. £19. 10s. 400

By BATTAM & CO.
Lee—19, Leyland-rd., l. 700
4, Leyland-rd., l. 910

By D. YOUNG.
Battersea, Hope-st.—"Bedford Cottage," f., r. £33. 16s. 230
New Cross-rd.—Nos. 237 and 239, u.t. 55 yrs., g.r. £14 955
Rotherhithe, Lower-rd. — A profit rental of £51. 15s., u.t. 59 yrs. 750
8 and 10, Old-rd., u.t. 61 yrs , g.r. £6, r. £57 420
52, West-lane, u.t. 785 yrs., no g.r., r. £22 140
12, 14, and 16, Plough-rd., u.t. 29 yrs. g.r. £7. 10s. 200
23, 25, and 27, Silwood-st., u.t. 66 yrs., g.r. £8. 17s., r. £87 650
Upper Clapton, High-rd. — A plot of land, u.t. 13 yrs., no g.r. 50
L.g.r. of £22. 10s. p.a., u.t. 13 yrs, ... 110

Nov. 14.—By FLOOD & SONS.
Westbourne-pk.—57, Tavistock-crescent, u.t. 74 yrs, g.r. £9. 410

By J. M. KLENCK & CO.
Hackney, 3, 4, and 5, Cossey-villas, f., r. £70 710

By DOWSETT & CO.
Camberwell-grove.—No. 169, f., r. £75 p.a. 950
Nos. 171, 173, and 175, Camberwell-grove, f., r. £214 p.a. 3,010

By NEWTON & HARDING.
Islington—Nos. 141, 142, and 143, Upper-st., and Myddleton Hall, f., area 8,230 ft. 8,100

By F. J. BISLEY.
Rotherhithe—6, Bush-rd., u.t. 49 yrs., g.r. £8. 12s. 600
35, Reculver-rd., u.t. 86 yrs., g r. £6 130
26, Colling-rd., u.t. 55 yrs., g.r. £5. 5s. 415
Bermondsey—11, 13, and 15, Yalding-rd., u.t. 45 yrs., g.r. £13. 2s. 6d., r. £93. 12s. 755
77, St. James's-rd., u.t. 50 yrs., g r. £3, r. £36. 8s. 340
Camberwell—72 and 74, Picton-st., f., r. £55. 5s. ... 550
Rotherhithe—98, Paradise-st., f., r. £31. 4s. 300

By C. C. & T. MOORE.
Stoke Newington—6, Church-rd., u.t. 71 yrs., g.r. £6. 6s. 350
St. George's-in-East—84, Christian-st., u.t. 10 yrs., g.r. £5. 5s. 120
Old Ford-rd.—No. 395, f., r. £24 p.a. 250
No. 399, f., r. £40 p.a. 320
Nos. 389 and 391, u.t. 78 yrs., g.r. £7 610
2, Wendon-st., f., r. £26 p.a. 230

Nov. 15.—By FOSTER & CRANFIELD.
North Finchley—1 to 4, Bangor-cottages, u.t. 91 yrs., g.r. £20 590

By P. HODSON.
Lower Clapton—27, Clifton-rd., u.t. 77 yrs., g.r. £5, r. £26 215

By WESTON & SON.
Brixton-hill—12 to 18 (even), Talma-rd., f., r. £120 1,690
89, Burton-rd., u.t. 25 yrs., g.r. £5. 4s. 250
Clapham—98 and 100, Lansdowne-rd., u.t. 52 yrs., g.r. £18, e.r. £110 710

[*Contractions used in this list.*—F.g.r. for freehold ground-rent; l.g.r. for leasehold ground-rent; i.g.r. for improved ground-rent; g.r. for ground-rent; r. for rent; f. for freehold; c. for copyhold; l. for leasehold; e.r. for estimated rental; u.t. for unexpired term; p.a. for per annum; yrs. for years; st. for street; rd. for road; sq. for square; pl. for place; ter. for terrace; yd. for yard, &c.]

MEETINGS.

SATURDAY, NOVEMBER 23.

University College, London (Archæology).—Demonstration at South Kensington Museum. 7 p.m.

MONDAY, NOVEMBER 25.

Surveyors' Institution.—Mr. E. Ryde on "The Tithe Question, with Suggestions for the Redemption of the rent-charge." 8 p.m.

TUESDAY, NOVEMBER 26.

Institution of Civil Engineers.—Further discussion on Mr J. I. Thornycroft's paper on "Water-tube Steam Boilers for Marine Engines." 8 p.m.

WEDNESDAY, NOVEMBER 27.

St. Paul's Ecclesiological Society.—Mr. Andrew Oliver on "Flemish Brasses in England." 7.30 p.m.

University College, London (Archæology).—Mr. Cecil H. Smith on "Persian Art." 5 p.m.

Society of Arts.—Dr. Gladstone, F.R.S., on "Scientific and Technical Instruction in Elementary Schools." 8 p.m.

THURSDAY, NOVEMBER 28.

Institution of Electrical Engineers.—Mr. G. L. Addenbrooke on "Electrical Engineering in America." 8 p.m.

University College, London (Archæology).—Demonstration at the British Museum. 5 p.m.

Edinburgh Architectural Association. — Mr. W. M. Conway, M.A., on "Egyptian Architecture." 8 p.m.

FRIDAY, NOVEMBER 29.

Architectural Association.—Mr. E. Pridham Warren on "The Decoration of Churches." 7.30 p.m.

Institution of Civil Engineers (Students' Meeting).—Mr. G. H. Sheffield on "Principles of Iron Foundry Practice." 7.30 p.m.

SATURDAY, NOVEMBER 30.

University College, London (Archæology).—Demonstration at the South Kensington Museum. 7 p.m.

Miscellanea.

Royal Meteorological Society.—The first meeting of this Society for the present session was held on Wednesday evening, the 20th inst., at the Institution of Civil Engineers, Dr. W. Marcet, F.R.S., President, in the chair. Nine new Fellows were elected. The following papers were read:—(1) "Second report of the Thunderstorm Committee." This is a discussion by Mr. Marriott on the distribution of days of thunderstorms over England and Wales during the seventeen years, 1871-87. Notices of sheet-lightning are included in the term "thunderstorms." The years of greatest frequency were 1880, 1882, 1884, and 1872, and the years of least frequency, 1887, 1874, 1879, and 1871. Years of greater or less frequency alternate regularly throughout nearly the whole of the period. The average yearly number of thunderstorms is about thirty-nine. The districts with the greatest yearly frequency are the south of England and extreme northern counties, and those with the least yearly frequency are Cheshire, Lancashire, and Yorkshire. The greatest number of thunderstorms occur in July, and the least in February and December. (2) "On the Change of Temperature which accompanies Thunderstorms in Southern England," by Mr. G. M. Whipple, B.Sc., F.R.Met.Soc. (3) "Note on the appearance of St. Elmo's Fire at Walton-on-the-Naze, Sept, 3, 1889," by Mr. W. H. Dines, B.A., F.R.Met.Soc. (4) "Notes on Cirrus Formation," by Mr. H. Helm Clayton. The author, who has made a special study of cloud-forms and their changes, gives a number of notes and drawings on the formation of cirrus under various conditions,—*e.g.*, in a previously cloudless sky, cirrus bands with cross fibres, cirrus from cirro-cumulus clouds, cirrus drawn out from cumulus clouds, "mares-tail" cirrus, &c. Curved cirrus clouds, when accompanied by decreasing barometric pressure, frequently indicate that a storm of increasing energy is approaching. (5) "A Comparison between the Jordan and the Campbell-Stokes Sunshine Recorder,' by Mr. F. C. Bayard, F.R.Met.Soc. As a result of a year's comparison between these two instruments the author found that the Jordan photographic recorder registered nearly 30 per cent. more sunshine than the Campbell burning recorder. (6) "Sunshine," by Mr. A. B. MacDowall. This is a discussion of the hours of sunshine recorded at the stations of the Royal Meteorological Society. (7) On "Climatological Observations at Ballyboley, Co. Antrim," by Professor S. A. Hill, B.Sc., F.R.Met.Soc. This is the result of observations made during the five years 1884-8.

The English Iron Trade.—Speculation is still an important factor in the English iron market, and has been the means of retarding legitimate business during the week. At the same time, the speculative fever has somewhat subsided. The demand for pig-iron would, no doubt, be greater if it were not for the upward tendency. Scotch warrants, after various fluctuations, have gained upon the week, while Scotch makers' iron is from 1s. to 3s. per ton dearer. Middlesbrough pig, after similar aberrations, closes the week a shade lower. Lancashire and Midland brands are quoted higher, and where transactions take place, the top prices are paid. In Bessemer pig the changes in quotations have been less pronounced, but its value has been increased 6d. per ton in the north-west. Owing to the high prices which manufacturers of finished iron are obliged to quote to meet the increasing cost of pig and fuel, both iron and steel are less eagerly bought. In the North of England, trade in manufactured iron is almost at a standstill, but high rates are less of a hindrance to business in Lancashire and Staffordshire. Steel material is quoted from 2s. 6d. to 12s. 6d. a ton higher in the North-west, but in the North of England rates have had to be lowered. Yet the demand for steel is almost as large as ever. Shipbuilders continue taking fresh orders for ships, and engineers are as busy as ever.—*Iron.*

The Acme Wood Flooring Company, Limited.—We are informed that the directors of this company have declared an interim dividend of 3¾ per cent. on the preference capital for the half-year ending October 31, 1889.

Carmarthen.—St. Mary's R.C. Church, Carmarthen, has been re-opened, after restoration, decoration, and improvements, under the direction of Mr. Albert Vicars, architect.

The Society of Arts.—The 136th session of the Society of Arts was opened on Wednesday evening at the Society's rooms, John-street, Adelphi. There was a large attendance. The Duke of Abercorn, as Chairman of the Council, had written the opening address, which, in the unavoidable absence of his lordship, was read by Sir F. Bramwell, who occupied the chair. It was a review of the Society's work since 1754. At that period little progress had been made in science. It was, however, a time when industrial activity was commencing, and the Society began its operations by offering prizes for inventions and improvements in connexion with arts and manufactures. As the country had been to a large extent denuded of timber by the necessity of building ships and by the wants of the iron manufactures, the Society offered numerous prizes for tree-planting. It was to this action that the existence to-day of many fine woods was due. Similar work was done by the Society in connexion with agricultural inventions. This system of awarding prizes for specified objects worked much good in its time; but the growth of science and its constantly-increasing application to industry rendered the system obsolete. Even yet, however, it was found occasionally useful to offer a prize for the purpose of directing public attention to some specified object. The principal work of the Society was now the dissemination, through meetings and lectures, of information on the relations of science and art to industry. The Society's exhibitions led to great international exhibitions of 1851 and 1862. In connexion with similar efforts, both at home and abroad, the Society had done good service. It was to this country's interest that she should take part in all important foreign exhibitions; and it seemed desirable that to promote that object some small sum should be given by the Government. If this were done, the Society would no doubt be ready to provide the necessary organisation, and to direct the expenditure. It was the Society that originated the system of local examinations directed from a single centre which had since developed into the Science and Art Department. They made the experiment of technological examinations, and as soon as it showed signs of success handed it over to the important organisation of the City Companies. The Society was now making a similar experiment with regard to examinations in commercial knowledge. Should it succeed, some body would, no doubt, be found to continue it on a larger scale than the Society's resources permitted. They claimed to have practically started the movement which had resulted in our art-industries of to-day, a matter which they had still in hand. After referring to other subjects in which the Society had done good work, the paper suggested that if they had sufficient funds they might carry out researches into problems of applied science. On the motion of Sir D. Galton, seconded by Lord A. Churchill, a vote of thanks to the writer and the reader of the address was unanimously accorded.

The Italian Building Crisis.—The building crisis in Italy again threatens to become serious, the advances made by the Government to certain banks in Turin and Rome heavily involved in the same having failed to afford the relief expected. In consequence, several contractors have suspended payment. It is feared that the reckless over-speculations in buildings in Turin and Rome carried on during the last two years may lead to a serious financial crisis in Italy this winter.

A Bridge across Behring Strait.—It is proposed in Russia to construct a bridge across Behring Strait from Siberia to Alaska, thus connecting the new and the old world. It is stated that the scheme is quite feasible, the narrowest part of the Strait being only 96 kilomètres. At this point there are besides three small islands, lying in almost a straight line, which would enable it to be made in four sections, each being shorter than those proposed for the Channel Bridge.

West Kirby.—The new buildings for the Wesleyan School Chapel consist of a chapel to seat 800 persons, with minister's vestry at the rear. The school premises consist of an assembly room and four class-rooms. The whole will be built of local red sandstone. The contract for the school buildings is let to Mr. W. Christian, of West Kirby, for £938. The contract for the chapel is not yet let. The architect is Mr. John Wills, of Derby.

Liverpool Engineering Society.—The fourth ordinary meeting of the sixteenth session of this Society was held in the Royal Institution, Colquitt-street, on Wednesday, Nov. 13, under the presidency of Mr. Henry H. West, M.Inst.C.E., &c., when a paper was read by Mr. George Farren, Assoc.-M.Inst.C.E., entitled, "The Stability of Earthwork and Masonry Dams." The paper, which was illustrated by many lantern views, dealt with the sources of the inherent weakness to which the failure of the Johnstown Dam in America was due, and embraced a description of dam designs in America, France, and Great Britain, with a contrast of the main differences of each. The great dams of Furens and Ban, which had been examined by Mr. Farren in connexion with the preparation of his paper, were also described in detail, and compared with our own Vyrnwy dam. With great elaboration Mr. Farren discussed, with the aid of diagrams, the construction of the latter in all its bearings. He contended that, compared with other dams now in existence, and apparently quite safe at the present day, the safety of the Vyrnwy dam, so far as it could be arrived at by calculation of known natural laws, was enormously in excess of these. The dam was, he said, not merely safe as regarded its base, but was theoretically and actually as safe throughout as human skill could make it.

Appointments.—At a meeting of the Wakefield Union Rural Sanitary Authority, held on Wednesday, the 13th inst., Mr. Frank Massie, Assoc.-M. Inst. C.E., F.S.I., was elected to the position of Engineer, Surveyor, and Waterworks Manager from amongst a hundred applicants. ——The Harbour Board of Southampton have appointed Mr. John H. Blizard, A.-M.Inst.C.E., and Mr. H. J. Weston, A.-M.Inst.C.E., Joint Quantity Surveyors for the Royal Pier Extension Works, to be carried out there. The works are expected to cost 20,000*l.*, and will be under the direction and supervision of Mr. J. G. Poole, the Surveyor to the Board.

Competition: Board Schools, Bromley. Mr. R. Norman Shaw, R.A., the referee, has reported in favour of the plans submitted in competition for the Aylesbury-road schools, for the Bromley School Board, Kent, by Mr. John Ladds, architect, and the Board have appointed him architect for the work.

PRICES CURRENT OF MATERIALS.

TIMBER.	£.	s.	d.	£.	s.	d.
Greenheart, B.G. ....ton	7	0	0	7	15	0
Teak, E.I.....load	12	0	0	14	0	0
Sequoia, U.S.....foot cube	0	2	3	0	3	0
Ash, Canada.....load	3	0	0	4	5	0
Birch ,, ...	3	0	0	4	15	0
Elm ,, ...	3	10	0	4	15	0
Fir, Dantsic, &c.	2	0	0	3	10	0
Oak ,, ...	2	10	0	4	10	0
Canada	5	10	0	7	0	0
Pine, Canada red	2	10	0	3	10	0
,, yellow	3	0	0	5	5	0
Lath, Dantsic.....fathom	4	10	0	5	10	0
St. Petersburg.....	5	0	0	6	10	0
Wainscot, Riga, &c.....log	2	15	0	4	5	0
Deals, Finland, 2nd and 1st...std.100	8	10	0	11	0	0
,, ,, 4th and 3rd.....	7	0	0	8	15	0
Riga	7	0	0	9	0	0
St. Petersburg, 1st yellow	11	0	0	14	0	0
,, 2nd ,, ...	9	0	0	11	0	0
,, white	6	10	0	10	0	0
Swedish	8	0	0	16	0	0
White Sea	9	0	0	17	0	0
Canada, Pine, 1st	16	0	0	26	0	0
,, ,, 2nd	11	0	0	17	10	0
,, ,, 3rd, &c.	8	0	0	10	10	0
,, Spruce, 1st	9	0	0	11	0	0
,, ,, 3rd and 2nd	7	0	0	9	0	0
New Brunswick, &c.	6	0	0	8	10	0
Battens, all kinds	6	0	0	17	0	0
Flooring Boards, sq., 1 in., prepared, First	0	11	0	0	14	0
Second	0	8	0	0	10	6
Other qualities	0	6	0	0	7	9
Cedar, Cuba.....foot	0	0	4½	0	0	5
Honduras, &c.....	0	0	4½	0	0	4½
Mahogany, Cuba	0	0	5	0	0	6½
St. Domingo, cargo average	0	0	5	0	0	6½
Mahogany—						
Mexican, cargo average	0	0	4½	0	0	5½
Tobasco ,, ...	0	0	5½	0	0	6½
Honduras ,, ...	0	0	5½	0	0	6½
Box, Turkey .....ton	4	0	0	13	0	0
Rose, Rio.....	15	0	0	20	0	0
Bahia	14	0	0	18	0	0
Satin, St. Domingo .....foot	0	0	9	0	1	6
Porto Rico	0	0	9	0	1	3
Walnut, Italian	0	0	4½	0	0	6½

METALS.						
Iron—Bar, Welsh, in London	0	0	0	0	0	0
,, ,, at works in Wales ...	0	0	0	0	0	0
,, Staffordshire, in London ...	0	0	0	0	0	0
Copper—						
British, cake and ingot..... ton	50	0	0	51	0	0
Best selected	51	0	0	52	0	0
Sheets, strong	59	10	0	0	0	0
Chili, bars	47	0	0	0	0	0
Yellow Metal.....lb.	0	0	5½	0	0	5½
Lead—Pig, Spanish .....ton	13	10	0	13	15	0
Lead—English, com. brands	13	10	0	13	15	0
Tin—Straits	95	10	0	0	0	0
Australian	0	0	0	0	0	0
English Ingots.....	100	10	0	0	0	0

OILS.						
Linseed .....ton	21	0	0	21	2	6
Cocoanut, Cochin	26	10	0	0	0	0
Ceylon	23	5	0	0	0	0
Palm, Lagos .....ton	26	0	0	0	0	0
Rapeseed, English pale	34	0	0	34	10	0
,, brown	32	15	0	33	0	0
Cottonseed, refined	23	15	0	0	0	0
Tallow and Oleine	21	0	0	40	0	0
Lubricating, U.S.	5	10	0	6	20	0
,, refined	7	0	0	12	0	0
Tar—Stockholm .....barrel	1	6	0	0	0	0
Archangel	0	15	6	0	15	9

COMPETITIONS, CONTRACTS, & PUBLIC APPOINTMENTS.

Epitome of Advertisements in this Number.

COMPETITIONS.

Nature of Work.	By whom Required.	Premium.	Designs to be delivered.	Page
Altering and Enlarging Asylum.....	Dorset County Lunatic Asylum.....	40*l.* and 20*l.*	Jan. 21st	ii.
New Conservative Club, Oswaldtwistle	The Building Committee	Not stated	Not stated.	i.

CONTRACTS.

Nature of Work or Materials.	By whom Required.	Architect, Surveyor, or Engineer.	Tenders to be delivered.	Page.
Repair of Private Roads	Croydon Corporation...	W. Powell	Nov. 26th	ii.
Supplying and Laying Water Pipes, &c.....	Pocklington Water Co. Lim.	Fairbank & Son	Nov. 27th	x.
Well Sinking.....	Com. of Sewers.....	*Official*	Nov. 29th	ii.
Alteration and Extension of Schools	Burton-on-Trent SchBd.	R. Churchill	Nov. 30th	ii.
Vagrant Wards.....	Amersham Union	*Official*	do.	ii.
Surface-Water Drains, &c.	Mortlake Highway Bd.	H. Richards	Dec. 2nd	ii.
Wrought-iron Fencing, Gates, Pillars, &c....	Hendon Local Board...	S. S. Grimsley	do.	x.
Cast-iron Pipes	Southend Local Board	P. Dodd	Dec. 3rd	x.
New Well	East Grinstead Gas and Water Company	E. Easton & Co.	do.	ii.
Alterations, &c., at Fire Brigade Stations ...	London County Council	*Official*	Dec. 4th	ii.
Stores	G. N. R. Co.	do.	Dec. 7th	ii.
Additions to Refuse Destructor.....	Bournemouth Commrs.	F. W. Lacey	Dec. 9th	x.
Underground Urinals and Water-closets.....	St. Pancras Vestry	W. B. Scott	do.	x.
Painting, Plumbing, Paving Works, &c.....	St. Olave's Union.....	Newman & Newman ...	Dec. 10th	x.
Roadmaking and Sewering Works.....	West Ham Council.....	Lewis Angell.....	do.	x.
Under-Drainage of Little Wormwood Scrubs	London County Council	*Official*	Dec. 11th	x.
Wrought-Iron Bar Fencing, Ravenscourt-pk	do.	do.	do.	x.
Roadmaking Works	Wood Green Local Bd.	do.	Dec. 13th	ii.
Roadmaking, &c., Canning Town	United Land Co. Lim.	do.	Dec. 16th	x.
Bakery, &c., Woolwich	War Department.....	do.	Not stated.	ii.
Materials for Repair of Permanent Way.....	London Street Tramways Co.	do.	do.	x.
New Church, Stoke-on-Trent	.....	C. Lynam	do.	ii.

PUBLIC APPOINTMENTS.

Nature of Appointment.	By whom Advertised.	Premium.	Applications to be in.	Page.
Surveyor	School Bd. for London	500*l.*	Nov. 30th	xvi.
Clerk of Works	York School Board.....	50*s.* weekly	do.	xvi.
Sanitary Inspector & Inspector of Nuisances	Bethnal Green Vestry	120*l.*	Dec. 2nd	xvi.
Drawing Clerk (Surveying Department).....	Hackney Bd. of Works	30*s.* weekly	do.	xvi.
Highway Surveyor.....	Gloucester C. C.	250*l.*	Dec. 6th	xvi.
County Surveyor.....	Glamorgan C. C.....	750*l.*	Dec. 20th	xvi.

TENDERS.

[Communications for insertion under this heading must reach us *not later than* 12 *noon on Thursdays.*]

AVONMOUTH.—For proposed alterations and additions to Mr. J. Hort's farm buildings, Avonmouth, in accordance with the plans of Mr. C. F. Millar, architect, Shirehampton, Bristol, on the estate of Mr. P. N. Miles, J.P.:—

E. Walters, Bristol	£1,240 0 0
E. T. Hatherley, Stoke Croft	1,175 0 0
George Humphreys, Bristol.....	1,050 0 0
H. A. Forse, Bristol.....	1,040 0 0
Stride & Davis, Shirehampton.....	1,020 0 0
J. Perkins, Bristol	985 0 0
J. Herd, Shirehampton	965 0 0
Ford & Sons, Cheddar.....	935 0 0
Pugsley, Clifton	919 0 0
W. Colston, Bristol	831 0 0
Hodge & Flower (accepted)	825 0 0

BATH.—For building a new billiard-room, for the Lansdown Grove Hotel Company, Limited. Mr. T. B. Silcock, architect, Bath:—

J. Foster, Bath (accepted)	£328 0 0

BROMLEY (Kent).—For works of surface drainage &c., in Beckenham-lane, for the Bromley Local Board. Mr. Hugh S. Cregeen, Surveyor:—

E. Peill & Sons...	£175 0 0
T. Lansbury (accepted).....	164 18 9

CATFORD.—For residence at Catford, for Dr. Hammersley (exclusive of decorations). Mr. Henry Hopton, architect, High-street, Lewisham:—

Kennard.....	£2,700 0 0
Laird	2,269 0 0
Lowe, Chislehurst (accepted)	2,174 0 0

KINGSTON.—For the Hook, Southborough, and Long Ditton Sewerage, for the Kingston Rural Sanitary Authority. Mr. William H. Hope, Engineer, Kingston-on-Thames:—

J. W. & J. Neave.....	£13,895 6 6
W. Neave & Son.....	13,819 18 9
Holme & King	13,211 11 10
T. Adams	12,977 1 7
John Mackay	12,561 18 8
W. I. Botterill	12,555 0 0
E. & W. Iles	11,899 0 0
G. Kavanagh	11,575 1 11
L. Bottoms	11,332 0 0
B. Cooke & Co.	10,679 0 0
W. Cunliffe (provisionally accepted)	10,421 0 0

JOHANNESBURG (Transvaal).—For adding a basement to the Johannesburg Stock Exchange, Post, and Telegraph Offices, for the Johannesburg Estate Company. Mr. Lennox Canning, A.R.I.B.A., and Fred G. Goad, C.E., architects, Johannesburg. Quantities by the architects:—

Contract No. 2.

A. L. Lawley (accepted)	£3,142 0 0

LINCOLN.—For the erection of premises on Waterside South, for Messrs. Doughty, Son, & Richardson, Lincoln:—

	A.	B.
Otter & Broughton...	£1,827 0 0	£1,800 0 0
J. M. Harrison	1,769 0 0	1,759 0 0
Lansdown & Son.....	1,752 17 11	1,740 0 0
H. S. & Wm. Close...	1,640 0 0	1,628 0 0
C. Sands	1,597 0 0	1,592 0 0
Wright & Sons	1,549 0 0	1,539 0 0
G. Cowen	1,549 0 0	1,534 0 0
J. W. Harrison*.....	1,397 0 0	1,383 0 0

* Accepted.

LINCOLN.—For the erection of premises, No. 37, Silver-street, for Mr. R. C. Carline. Mr. William Watkins, F.R.I.B.A., architect, St. Edmund's-chambers, Lincoln:—

J. W. Harrison.....	£1,450 0 0
Otter & Broughton	1,424 0 0
J. B. Harrison	1,420 0 0
Wright & Sons	1,374 0 0
H. S. & William Close	1,248 0 0
J. M. Harrison (accepted)	1,180 0 0

LONDON.—For the erection of central offices for the Institute of Chartered Accountants in England and Wales, at Coleman-street-buildings, Moorgate-street, E.C. Mr. John Belcher, F.R.I.B.A., architect. Quantities by Mr. R. C. Gleed:—

Dove Bros.	£26,145 0 0
Foster & Dicksee	25,057 0 0
Cubitt & Co.	24,670 0 0
Downs	24,620 0 0
J. and J. Greenwood	24,560 0 0
Hall, Beddall, & Co.....	24,215 0 0
Colls & Sons.....	23,940 0 0
Perry & Co.....	23,534 0 0
Bissett & Sons, Sheffield.....	22,996 0 0

LONDON.—For alterations to the "Cock Tavern," Holloway-road, N., in forming entrance and new staircase to billiard-room, with all necessary lavatory accommodation, for Mr. Frederick Hall. Mr. A. J. Perriam, architect, 52, St. John's-villas, Upper Holloway:—

Wm. Evans, Upper Holloway (accepted)...	£272 0 0

[Without competition.]

LONDON.—For additions to factory, Valentine-place, Blackfriars-road, for Mr. James Pascall. Mr. W. H. Woodroffe, architect :—

Colls & Son	£3,954	0	0
Higgs & Hill	3,930	0	0
Smith & Son	3,847	0	0
W. Downs	3,831	0	0
Hall, Beddall, & Co.	3,774	0	0
Hoare & Son	3,740	0	0
Wall Bros.	3,677	0	0
P. Parker	3,550	0	0
Outwaite & Son (accepted)	3,485	0	0

LONDON.—For additions to dairy farm, Stanhope-road, Hornsey-lane, N., for Mr. J. F. Spencer. Mr. Henry S. Tyack, architect, 6, Duke-street, Adelphi :—

Mattock Bros.	£779	0	0
Hayworth & Sons	697	0	0
Burman & Sons	690	0	0
P. M. Kessels	626	8	0
F. Voller, Truro-road, Wood Green*	579	0	0

* Accepted.

NEWPORT (Mon.).—For the erection of one block of model lodging-houses in Dock-street, Newport, for the Newport Model Lodging House Company. Mr. E. A. Lansdowne, architect, Newport. Quantities by the architect :—

Francis & Son	£2,950	0	0
H. C. Parfitt	2,670	0	0
Gadwell (executors of Messrs.)	2,550	0	0
W. A. Linton	2,548	0	0
W. Blackburne	2,495	0	0
J. Linton (accepted)	2,460	0	0

[All of Newport.]

NEWPORT (Mon.).—For the erection of two small cottages at Panteg for Mr. F. Phillips. Mr. E. A. Lansdowne, architect, Newport :—

John Burgoyne, Pontypool	£340	0	0
Morgan and Evans, Pontypool*	327	0	0

* Accepted.

NEWPORT (Mon.).—For the erection of two cottages with house and shop on the Llanover Estate, at Newbridge, for Mr. James Griffiths. Mr. E. A. Lansdowne, architect :—

C. Morgan, Newbridge (accepted)	£715	0	0

READING.—For the erection of a block of cottages on the Coley Park Estate, Reading, for Mr. J. Bligh Monck, J.P. Messrs. Cooper & Son, architects, Blagrave-street, Reading. Quantities by the architects :—

Winter & Fitt	£2,486	0	0
J. Wicks	2,375	0	0
Collier & Catley	2,340	0	0
Bottrill & Son	2,285	0	0
Geo. S. Lewis	2,247	0	0
Higgs & Son	2,179	0	0
Wm. Goodchild	2,178	0	0
Geo. Wernham (accepted)	2,150	0	0

[All of Reading.]

SYDENHAM.—For winter garden, at Horner Grange, for Mr. W. Knight. Mr. J. Fogerty, architect, 51 and 52, Suffolk House :—

Lascelles & Co. (accepted)	£2,300	0	0

WINDSOR.—For works at the "White Hart" Hotel, Windsor, for Mr. Martin. Mr. R. Robson, architect :—

Frank Akery	£11,800	0	0
Dove Bros,	11,775	0	0
Lansdown & Co.	11,478	0	0
Peto Bros.	10,989	0	0
Silver & Sons	10,940	0	0
Perry & Co.	10,697	0	0
William Johnson	10,450	0	0
*F. H. Adamson & Son	10,060	0	0
*J. Botterill & Son	9,987	0	0
Chas. Oldridge & Son	9,984	0	0
Chas. Woodbridge	9,949	0	0
*Winter & Fitt	9,895	0	0
Wm. Watson	9,895	0	0

Those marked * do not accept condition of tender.

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TO CORRESPONDENTS.

Letter about Westminster Abbey (no name or address given).—J. M.—M. J. J.—W. A. B. (too late).

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80 to 90, BOND STREET, VAUXHALL, and
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MICHELMORE & REAP,
Manufacturers of

COLLINGE'S PATENT HINGES, LEVER, SCREW, & BARREL BOLTS,
Self-Acting "FALL DOWN" GATE STOPS,
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PRICES REDUCED. LIST SENT ON APPLICATION.

TWELVE GOLD AND SILVER MEDALS AWARDED.

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LONDON. ✦✦ LIVERPOOL. ✦✦ GLASGOW.

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NO SOLDER. NO EXTERNAL FASTENINGS.

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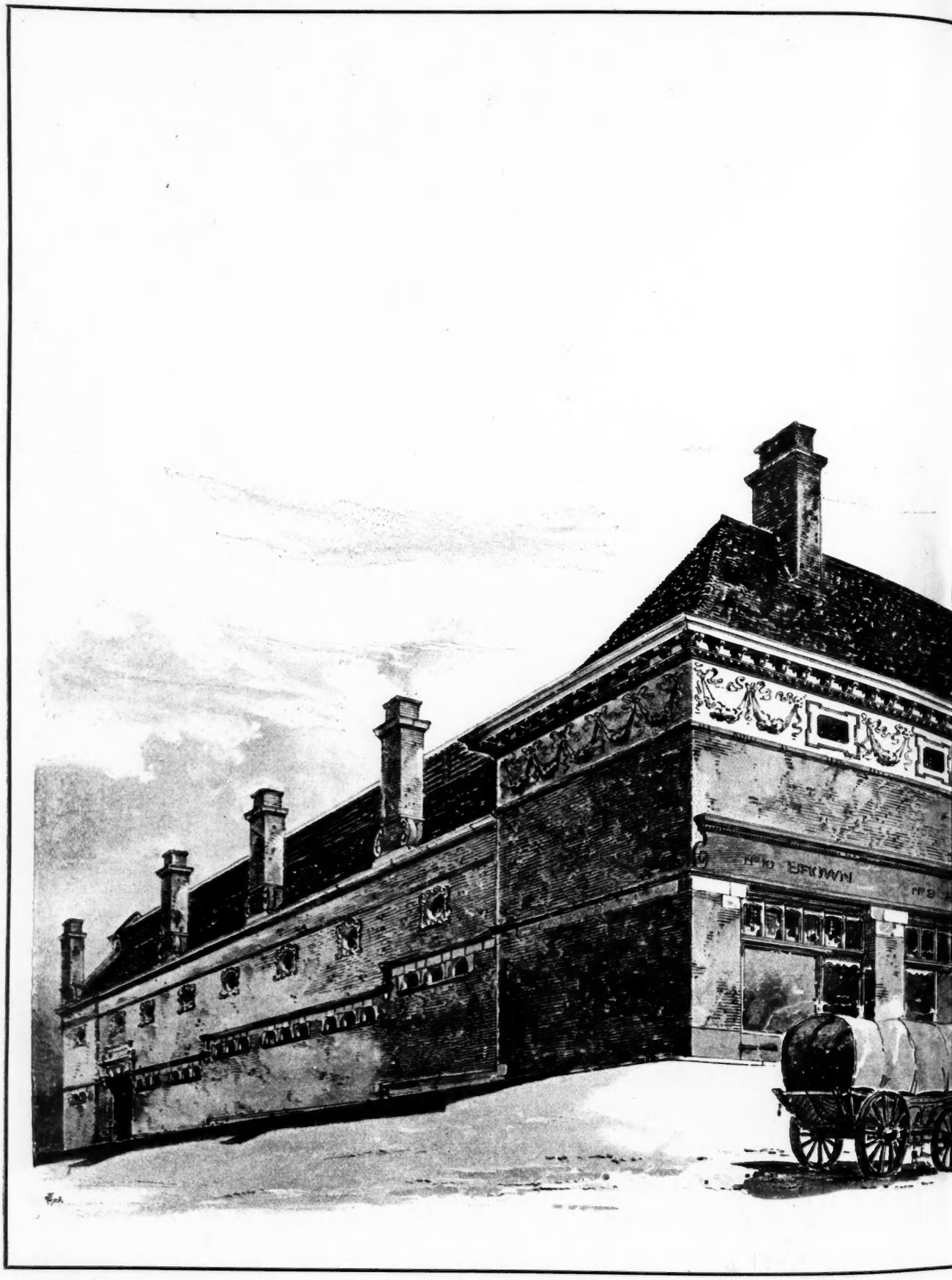


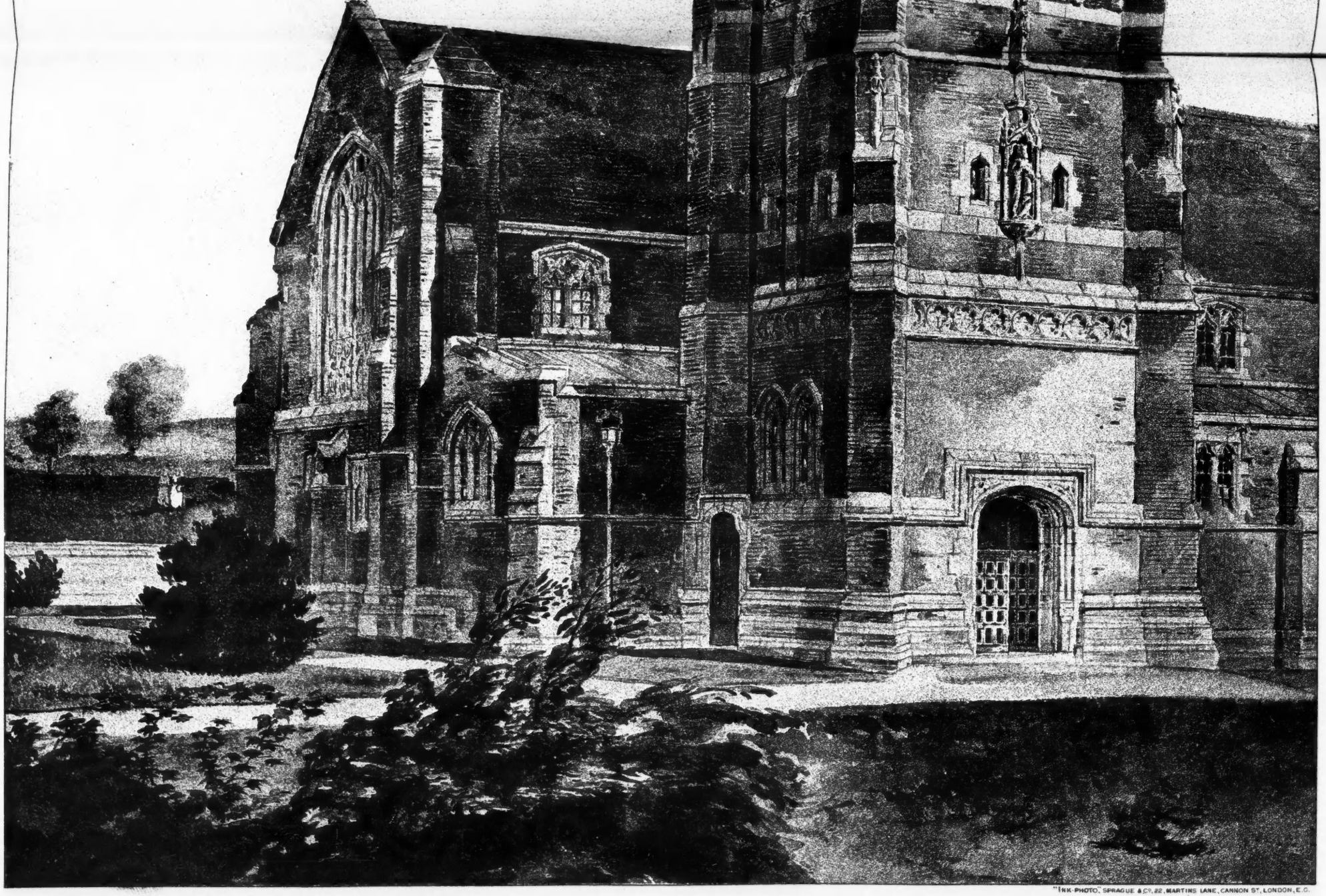
DESIGN FOR NEW MA

MITCHELL &

The Phototype Co., 303, Strand, London.

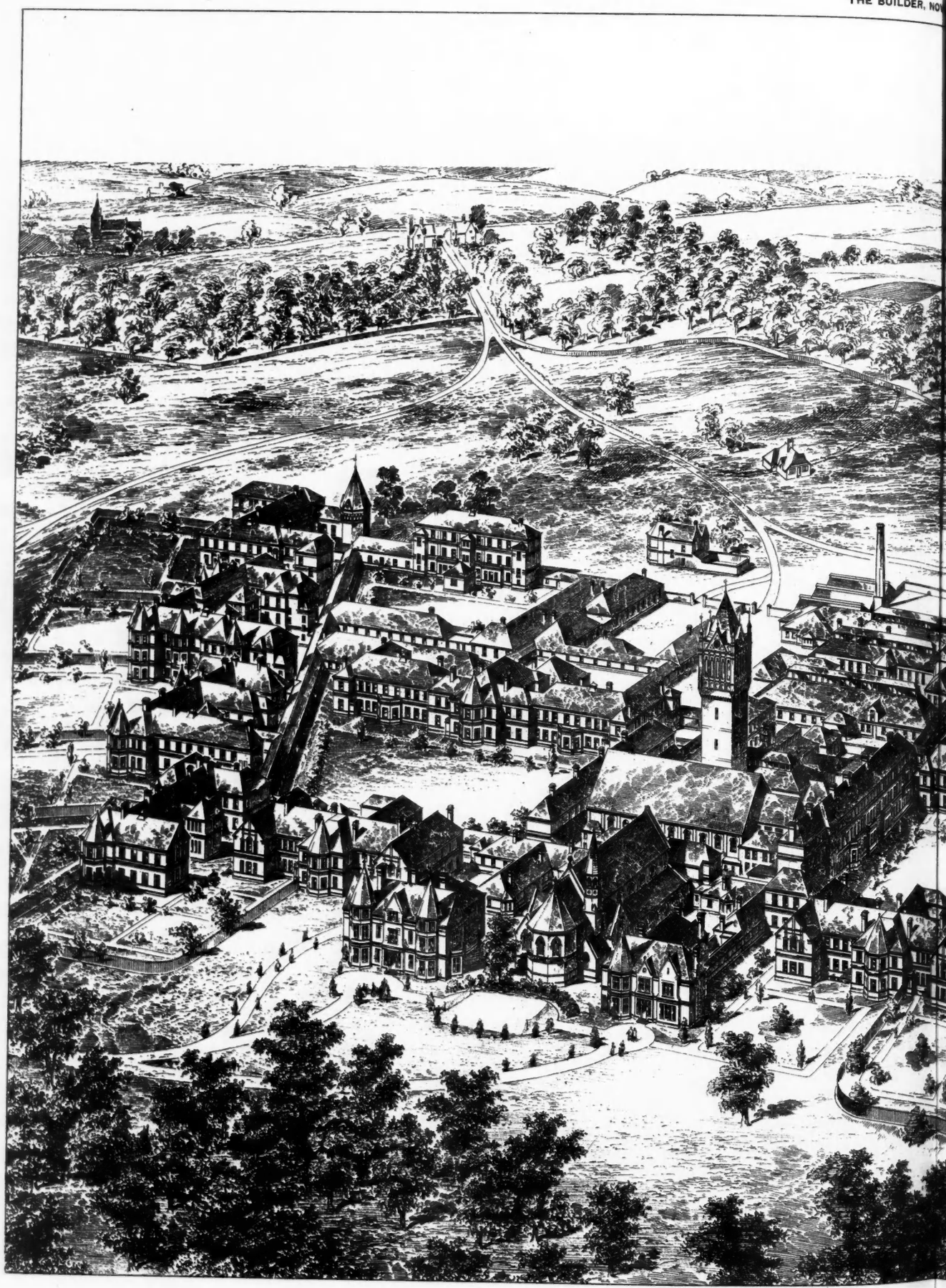
W MARKET HALL, ROTHERHAM.

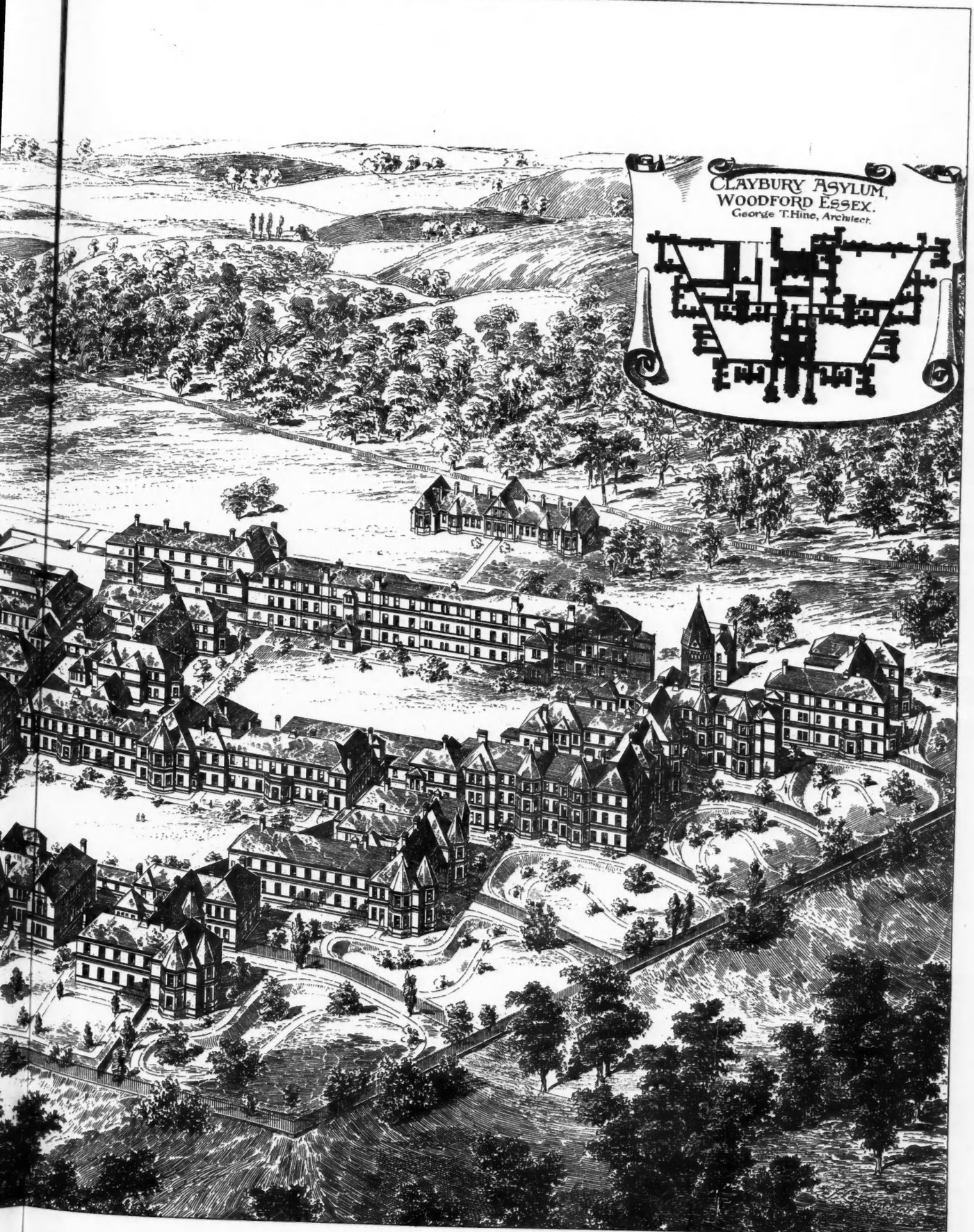
HELL & BUTLER, ARCHITECTS.



"INK-PHOTO," SPRAGUE & Co., 22, MARTINS LANE, CANNON ST., LONDON, E.C.

ST. JOHN'S CHURCH, STANSTEAD-MONT-FITCHET: TOWER AND WEST END.—Mr. W. D. Caröe, Architect.





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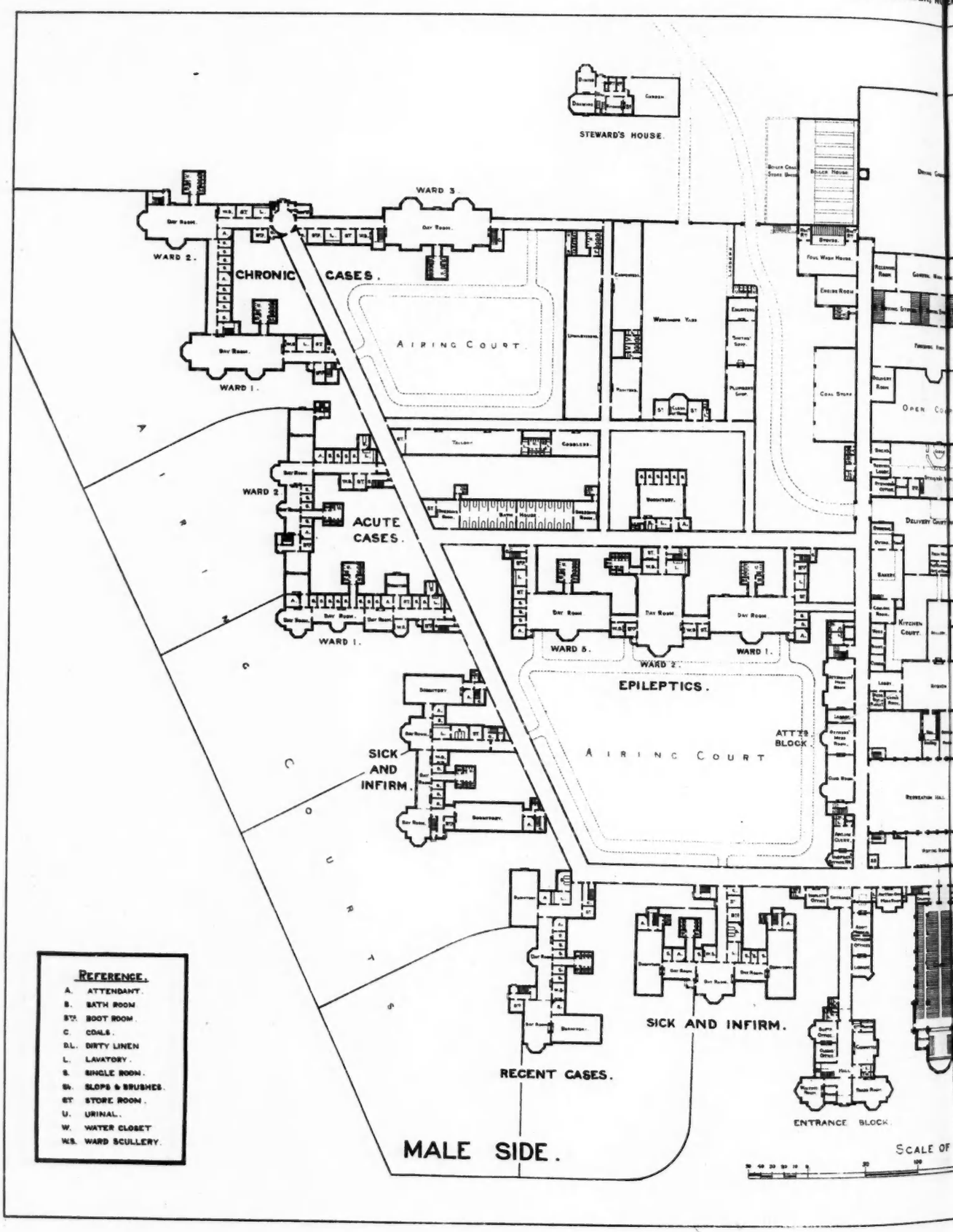
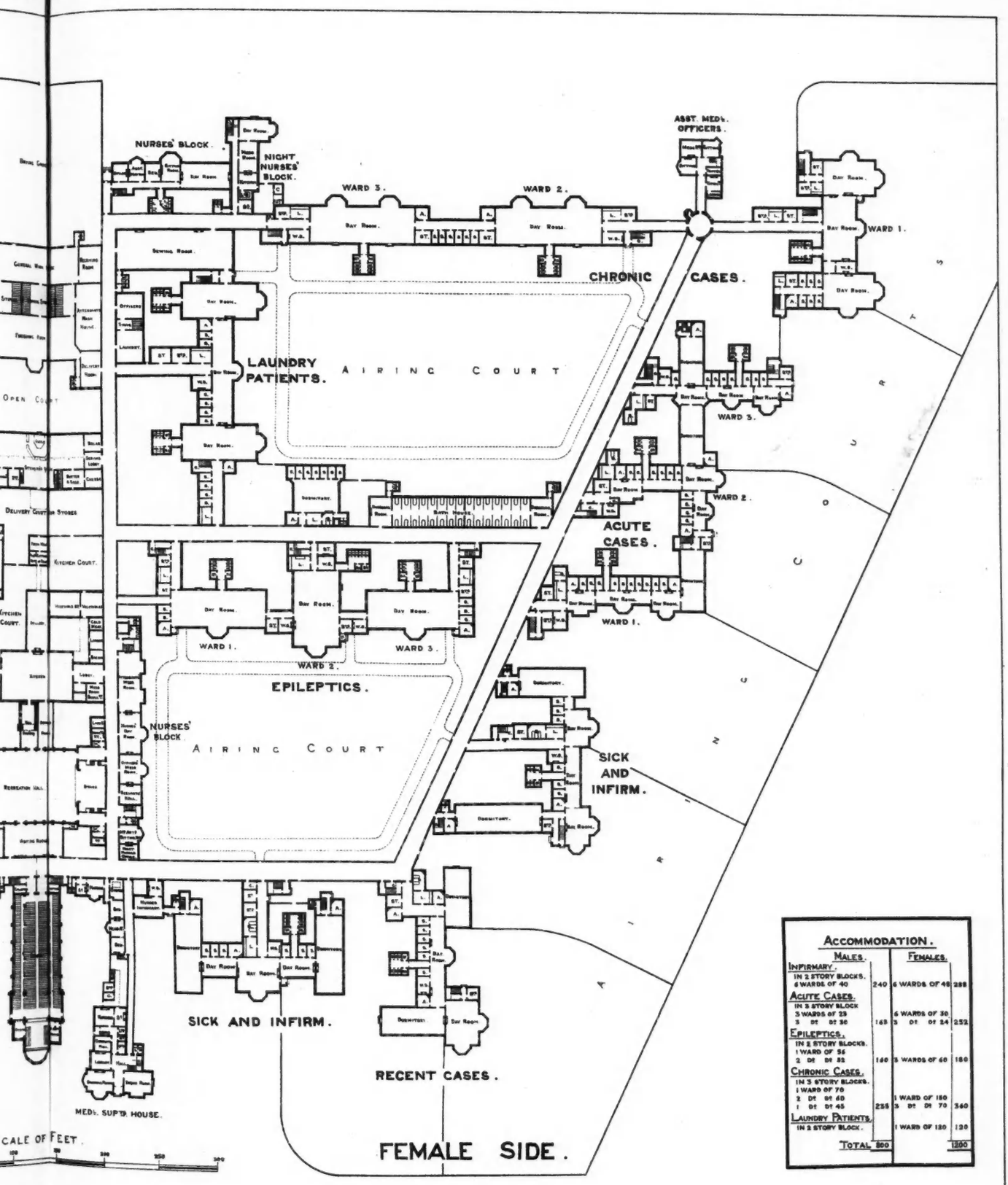


MIDDLESEX FOURTH ASYLUM, CLAYBU

GROUNI



ACCOMMODATION.

	Males.		Females.	
Infirmary.				
In 2 story blocks.				
6 wards of 40	240	6 wards of 48		288
Acute Cases.				
In 3 story block				
3 wards of 29		6 wards of 30		
3 Dt Dt 36	149	3 Dt Dt 24		252
Epileptics.				
In 2 story blocks.				
1 ward of 56				
2 Dt Dt 32	120	3 wards of 60		180
Chronic Cases.				
In 3 story blocks.				
1 ward of 70				
2 Dt Dt 60		1 ward of 150		
1 Dt Dt 45	235	3 Dt Dt 70		360
Laundry Patients.				
In 2 story block.		1 ward of 120		120
Total	800			1200

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CLAYBURY, ESSEX.—Mr. G. T. Hine, Architect.

GROUND PLAN.